MISCELLANEOUS PAPER NO. 6-730

INVESTIGATION OF CONCRETE AGGREGATES AND RIPRAP, KASKASKIA RIVER, ILLINOIS NAVIGATION IMPROVEMENT

by

B. J. Houston

A. D. Buck

August 1965

Sponsored by

U. S. Army Engineer District
St. Louis

Conducted by

U. S. Army Engineer Waterways Experiment Station
CORPS OF ENGINEERS
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ARMY-MRC VICKSBURG, MISS

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FOREWORD

The investigation reported herein was authorized by letter dated 11 March 1965 from U. S. Army Engineer District, St. Louis, subject, "Request for Testing Concrete Aggregate and Riprap, Kaskaskia River, Illinois, Navigation Improvement."

The work was performed at the LMVD Materials and Concrete Laboratory, U. S. Army Engineer Waterways Experiment Station (WES), under the direction of Mr. Thomas B. Kennedy, and the supervision of Messrs. J. M. Polatty, Bryant Mather, R. L. Curry, W. O. Tynes, E. E. McCoy, A. D. Buck, W. I. Luke, and B. J. Houston, and Mrs. Katharine Mather. This report was prepared by Mr. Houston and Mr. Buck.

Director of WES during the performance of the investigation and preparation of the report was Colonel John R. Oswalt, Jr., CE. Technical Director was Mr. J. B. Tiffany

CONTENTS

SUMMARY

In order to determine relevant properties of materials present in locally available sources of concrete aggregate and riprap for use in the Kaskaskia River, Illinois, Navigation Improvement project in the St. Louis District, a number of sources were selected for investigation. The coarse aggregate and riprap materials submitted for testing were crushed limestone, and the fine aggregate was a natural sand which was deficient in the fine fractions. A supply of fine sand was submitted for use in making up the size deficiencies. Of the five coarse aggregate sources tested, four were considered as potential suppliers of both riprap stone and coarse aggregate. The other source was considered only as a supplier of riprap.

The results of the examinations and tests indicate that none of the materials contain features or possess properties that render them definitely unsuitable for the purposes for which they were tested. The lower 35-ft ledge of West Lake Quarry, however, contained rock capable of dedolomitization reaction in concrete, and aggregate from this ledge should not be used alone in concrete, but if all three ledges in the quarry are worked simultaneously the resulting aggregate would probably not be expansive in concrete. This aggregate as well as the fine aggregate tested should only be used with low-alkali cement. Rock from the other sources considered as coarse aggregate did not contain dolomite proportions in the reactive range.

Stone from all five sources should be satisfactory for use as riprap provided shaly fractions in some sources are not allowed to become concentrated enough to have an adverse affect on the ability of the stone to withstand severe weather and remain intact in large pieces.

INVESTIGATION OF CONCRETE AGGREGATES AND RIPRAP, KASKASKIA RIVER, ILLINOIS, NAVIGATION IMPROVEMENT

PART I: PURPOSE AND SCOPE

Purpose

1. The purpose of the work was to determine relevant properties of materials present in locally available sources of concrete aggregate and riprap for use in the subject project.

Scope

2. Crushed stone from four quarries was tested for use as both concrete aggregate and riprap. Crushed stone from another quarry was tested for use as riprap. A river sand from Chester, Illinois, and a fine blending sand from Evansville, Illinois, were tested for use as concrete sand.

PART II: SAMPLES AND TESTS

Samples

3. Source information data on samples submitted for testing are as follows:

a. Gibbar Quarry No. 4

State:	Missouri
Latitude:	37°
Longitude:	89°
Location:	Sec 11, R 12 E, T 35 N, Perry Co., Mo., near Red Rock, Mo.
Producer:	Southern River Rock Co., Box 33, Perryville, Mo.
Geologic formation and age:	Plattin limestone, Middle Ordovician Age
Remarks:	This hillside quarry is currently worked in two ledges, an upper ± 60-ft ledge above the 5- to 6-ft shaly zone and a lower ± 45-ft ledge below the shale. The shaly zone is wasted. This quarry has previously supplied shovel-run 5000-lb dike stone and 150-lb riprap for river projects.

b. West Lake Quarry No. 5

State:	Missouri
Latitude:	38°
Longitude:	90°
Location:	Sec 17, R 9 E, T 38 N, Ste. Genevieve Co., Mo., at Little Rock, Mo.

Producer: West Lake Quarry and Material Co., Box 206, Taussig Road, Bridgeton, Mo.

Geologic formation and age: Ste. Genevieve limestone and St. Louis limestone, Meramec group, Middle Mississippian Age

Remarks: This open quarry is currently worked in three ledges, an upper ± 30-ft ledge in the Ste. Genevieve limestone, a middle ± 80-ft ledge, and a lower ± 35-ft ledge, all in the St. Louis limestone. This source has previously supplied only 5000-lb shovel-run dike stone for river projects.

c. <u>Stotz Quarry</u>

State: Illinois

Latitude: 38°

Longitude: 90°

Location: Sec 16, R 9 W, T 5 S, Randolph Co., Ill. 1/2 mile north of Prairie du Rocher, Ill.

Producer: Stotz Quarry, Prairie du Rocher, Ill.

Geologic formation and age: Salem limestone, Meramec group, Middle Mississippian Age

Remarks: This source currently mines three ledges, an upper ± 13-ft ledge, a middle ± 10-ft ledge, and a lower ± 14-ft ledge. In every ledge the in-place stone appears very similar, and materials in stockpile cannot be easily referred to an individual ledge. In the mine, the upper and middle ledges and the middle and lower ledges are occasionally worked as a unit. In perhaps three years, the operator plans to mine all three ledges in one unit. The crushed stone samples represent the lower ± 14-ft ledge. The ledge samples marked No. 1 represent the upper ± 13-ft ledge and the middle ± 10-ft ledge. The ledge samples marked No. 2 represent the lower ± 14-ft ledge.

d. Charlie Bussen Quarry

State:	Missouri
Latitude:	38°
Longitude:	90°
Location:	Sec 12, R 8 E, T 38 N, Ste. Genevieve Co., Mo.
Producer:	Charlie Bussen Quarry, Ste. Genevieve, Mo.
Geologic formation and age:	Salem limestone, Meramec group, Middle Mississippian Age
Remarks:	This open quarry is worked in five ledges, four of which have been previously approved for river projects and are here represented by the ledge samples.

e. Menefee Quarry

State:	Missouri
Latitude:	38°
Longitude:	90°
Location:	Sec 24, R 7 E, T 39 N, Ste. Genevieve Co., Mo., 1/2 mile southwest of Brickeys, Mo.
Producer:	Menefee Crushed Stone Co., Inc., P. O. Box 387, Nashville, Tenn.
Geologic formation and age:	Kimmswick limestone, Middle Ordovician Age
Remarks:	Two pits are present at this location, an upper, or western pit, and a lower, or eastern, pit. The samples represent the ± 15-ft ledge exposed at the lower pit. This source has previously supplied 5000-lb shovel-run dike stone and 150-lb riprap to river projects.

f. Southern Illinois Sand Co. (see TM No. 6-370, Vol IV)

Latitude:	37°
Longitude:	89°

g. Siegfried Fine Sand

State:	Illinois
Latitude:	38°
Longitude:	89°
Location:	2-1/2 miles southwest of Evansville, Ill., Randolph Co., Ill.
Producer:	Ruma Asphalt Co., Ruma, Ill.
Geologic formation and age:	Residual Cypress sandstone, Upper Mississippian Age
Remarks:	This newly opened pit supplies fine sand to the Ruma Asphalt Co. Fine sand is excavated in the dry and is loaded directly on trucks, without processing. Two ft of soil overburden is stripped and wasted prior to excavating the under lying 12 ft of fine sand.

4. The material was given the following laboratory serial numbers.

CD No.	Source	Material	Amount
STL-19 G-1	Gibbar Quarry No. 4 near Red Rock, Mo.	6-in. core	26 boxes 4400 lb
STL-19 G-2	West Lake Quarry No. 5, Little Rock landing near Ste. Genevieve, Mo.	6-in. core	32 boxes 5400 lb
STL-19 G-3	Stotz Quarry, Prairie du Rocher, Ill	Crushed stone	5680 lb
STL-19 G-3(A)		Upper 13- and middle 10-ft ledge	1600 lb
STL-19 G-3(B)		Lower 14-ft ledge	

CD No.	Source	Material	Amount
STL-19 G-4(A)	Charlie Bussen Quarry, Ste. Genevieve, Mo.	Ledge No. 1	3200 lb total
STL-19 G-4(B)		Ledge No. 2	
STL-19 G-4(C)		Ledge No. 3	
STL-19 G-4(D)		Ledge No. 4	
VICKS-35 G-1(2)	Menefee Quarry, Brickeys, Mo.	Ledge stone	8300 lb
STL-5 S-3(4)	Southern Illinois Sand Co. Chester, Ill.	River sand	3600 lb
STL-19 S-1	Siegfried Fine Sand, near Evansville, Ill.	Natural sand	480 lb

Tests

5. Logging of cores. The cores from Gibbar and West Lake Quarries were logged in sufficient detail to determine if potentially reactive carbonate rock was present. Shaly material representing a 4- to 5-ft zone between the upper 60-ft ledge and lower 45-ft ledge of Gibbar Quarry was logged and then discarded as this zone is wasted during quarrying operations.

6. Petrographic examination of ledge rock. Ledge rock from Stotz and Bussen Quarries were examined for presence of potentially reactive carbonate rock.

7. Petrographic examination of crushed material and sand. A portion of ledge stone from Menefee Quarry was crushed and recombined according to

OCE Guide Specifications into No. 4 to 3/4-in., 3/4- to 1-1/2-in., and 1-1/2- to 3-in. size groups. A petrographic examination was made of sieve splits of No. 4 to 3-in. sizes. An examination of splits of Siegfried fine sand was also made.

8. Samples tested for use as riprap. The material from the upper ledge of Gibbar Quarry was separated into two lithological rock types for testing. It was found that the core from the lower ledge was so fractured that it was impossible to get samples for riprap tests. The stone from West Lake Quarry was tested as four lithological types. The stone from Stotz Quarry represented two ledges, the upper ledge was divided into two lithological types for tests; the lower ledge was tested as only one type. The stone from Bussen Quarry represented four ledges. The third ledge was divided into two lithological types, while the other three ledges were tested as one type each. The stone from Menefee Quarry represented one ledge and was tested as one lithological type.

9. Each sample or lithological rock type was subjected to the following tests, using applicable procedures from the Handbook for Concrete and Cement:

a. Specific gravity (unit weight) and absorption, CRD-C 107.

b. Abrasion, grading E, CRD-C 117.

c. Toughness, CRD-C 132.

d. Freezing and thawing, CRD-C 144.

10. Acceptance tests for use as concrete aggregate. Samples of stone from Gibbar, West Lake, Stotz, and Menefee Quarries were tested

for use as concrete aggregate. Three size groups were tested which were No. 4 to 3/4-in., 3/4- to 1-1/2-in., and 1-1/2- to 3-in. Each size group from each quarry, where applicable, was subjected to the following tests:

a. Sieve analysis, CRD-C 103.

b. Specific gravity and absorption, CRD-C 107.

c. Soundness, CRD-C 115.

d. Abrasion, CRD-C 117.

e. Flat and elongated, CRD-C 119.

f. Scratch hardness, CRD-C 130.

11. The Seigfried and Southern Illinois fine aggregate were subjected to the following physical tests:

a. Sieve analysis, CRD-C 105, CRD-C 103.

b. Specific gravity and absorption, CRD-C 108.

c. Organic impurities, CRD-C 121.

d. Mortar-making properties, CRD-C 116.

12. Freezing and thawing of concrete aggregate. The No. 4 to 3/4-in. fractions of the material from Gibbar, West Lake, Stotz, and Menefee Quarries were tested in combination with Southern Illinois and Siegfried sand according to test method CRD-C 114.

PART III: RESULTS AND CONCLUSIONS

Results

13. Logging of cores. Cores from Gibbar and West Lake Quarries were logged and the results are given in the petrographic report, WES Form 1115. The log indicated that the core from Gibbar Quarry, which is worked in two ledges, was primarily dolomite. The core from the lower ledge had an abundance of vertical fractures and closely spaced bedding planes which prevented testing of this material for use as riprap. Except for the bottom 3.5 ft of the core from the lower ledge, the dolomite contents of the core from both ledges fell outside the range in which deleterious dedolomitization occurs. Core from the upper ledge of West Lake Quarry, which is worked in three ledges, was primarily oolitic and dense limestone with a little shaly limestone and clay, while that of the middle ledge was dense and dolomitic limestone with some stylolitic limestone and scattered layers of shale, and that from the lower ledge was oolitic and dense limestone and fine to medium grained dolomitic limestone. The rock in the upper ledge should not be subject to dedolomitization if used as concrete aggregate. Properties of dolomite and calcite in the core from the middle ledge indicated probable potential reactivity and this was confirmed by testing small 0.35-in.-diameter cores drilled from the larger cores for length change in 1-N NaOH. The expansion of the small cores indicates that rock from depths 90 to 104 ft, which probably represents the top of the lower 35-ft ledge, would

produce expansive reaction in concrete; however, if all three ledges are simultaneously quarried, the resulting aggregate would not be sufficiently expansive to be harmful in concrete. The core from the lower ledge was highly fractured, but this is not caused by bedding planes and is probably a localized condition.

14. Petrographic examination of ledge rock. None of the ledge rock from Stotz Quarry, which was from three separate ledges, contained calcite-dolomite in proportions regarded as dangerous. This material was mainly dense limestone with a moderate amount of shaly limestone. Ledge rock from Bussen Quarry, representing four ledges, was found to be mainly dense limestone with a moderate amount of shale, especially in ledge 3. This material would not be expansive in concrete. The ledge rock from Menefee Quarry represented one ledge and was limestone. This material would not be expansive in concrete.

15. Petrographic examination of crushed material and sand. Crushed aggregate of 3-in. maximum size from Bussen Quarry was examined. This material is expected to produce suitable concrete aggregate. The Siegfried fine sand was examined and found to be primarily quartz with about 10 percent chert. If the volume of this sand used in concrete is such that the chert amounts to 5 percent or more of the fine aggregate, low-alkali cement should be specified.

16. Samples tested for use as riprap. Samples of rock from Gibbar, West Lake, Stotz, Bussen, and Menefee Quarries were tested for use as riprap. The results are given in table 1 and on inclosed WES Forms 726

and 1115. The material from the upper ledge of Gibbar Quarry was satisfactory in all tests except the dolomite had a slightly high absorption (1.7), and the effect of freezing and thawing was greater than for the other four sources tested. Samples from the lower ledge were not tested because of its fractured condition. The rock from West Lake Quarry was satisfactory in all tests except the toughness test of the dense limestone. The rock from Stotz Quarry was satisfactory in all tests. The material from Bussen Quarry was satisfactory in all tests except the rock from ledge 1 and the shaly limestone from ledge 3 had a slightly high absorption. The rock from Menefee Quarry had a high abrasion loss and failed the toughness test. It was, however, perhaps the least affected by freezing and thawing of all sources tested and was the most uniform material.

17. Acceptance tests for use as concrete aggregate. Samples of stone from Gibbar, West Lake, Stotz, and Menefee Quarries were tested for use as coarse aggregate in concrete and the results are shown in table 1 and on WES Forms 726 and 477. All stone was satisfactory except the stone from Menefee Quarry and the No. 4 to 3/4-in. size group of the stone from Stotz Quarry which exhibited a slightly high abrasion loss (CRD-C 117), and the stone from Menefee Quarry also had a high percentage of soft particles. Samples of Mississippi River sand (STL-5 S-3(4)) and fine blending sand (STL-19 S-1) were given abbreviated tests for use as concrete sand. The river sand was found to contain organic impurities as shown by CRD-C 121, but strength tests indicate that these did not have a significant effect in reducing strength of mortar made with it.

18. Freezing-and-thawing test of concrete aggregate. The results of the freezing-and-thawing tests are as follows:

Material	DFE_{300}
Stotz	81
Menefee	81
West Lake	80
Gibbar	71

The material from Stotz, Menefee, and West Lake Quarries withstood freezing and thawing slightly better than the material from Gibbar; however, the material from all four sources appears to be of such a nature as not to adversely affect the resistance to freezing and thawing of concrete containing it.

Conclusions

19. Riprap. The bedding of the limestone from all five quarries is thick enough to allow production of blocks massive enough for riprap. Rock from the Menefee and Bussen Quarries were least affected by freezing and thawing. The results of the examinations and tests indicate that riprap not possessing undesirable properties can be produced from all the sources evaluated provided the shaly limestone portions are wasted.

20. Concrete coarse aggregate. The results of examinations and tests indicate that concrete aggregate free of undesirable properties can be produced from all the sources evaluated.

21. Concrete fine aggregate. A blend of the two fine aggregates tested would probably contain enough alkali-silica reactive ingredients

to make it mandatory that low-alkali cement be used in concrete containing these aggregates. With low-alkali cement these fine aggregates would not be expected to manifest unsatisfactory performance in concrete.

TABLE 2

Test Results of Stone from Proposed Sources of Riprap
Kaskaskia River, Illinois, Navigation Improvement

	Bulk Sp Gr SSD	Unit Wt, lb/cu ft	Absorp. %	L. A. Abrasion Loss, %	Toughness, Height, cm, Perpendicular to Joint Plane	Toughness, Height, cm, Parallel to Joint Plane	% Loss F&T in Alcohol and Water 20 Cycles
Gibbar Quarry No. 4							
STL-19 G-1							
Dense Limestone	2.69	167.6	0.4	28.5	7	5	*
Dolomite	2.68	167.0	1.7	30.9	7	7	13.0
West Lake Quarry No. 5							
STL-19 G-2							
Dense Limestone	2.66	167.5	0.3	33.4	7	4	6.8
Oolitic Limestone	2.65	165.1	0.2	24.9	9	6	0.2
Soft Weathered Limestone	2.52	157.0	2.2	30.1	5	5	2.8
Shaly Limestone	2.67	166.3	0.2	31.0	11	9	9.0
Stotz Quarry							
STL-19 G-3(A)							
Dense Limestone	2.67	166.3	0.4	32.8	7	7	0.9
Shaly Limestone	2.66	165.7	0.6	25.8	7	8	5.4
STL-19 G-3(B)							
Dense Limestone	2.68	167.0	0.4	29.8	8	7	0.4

* One of the three samples disintegrated at 17 cycles; the other two had a weight loss at 20 cycles of 0.3 and 6.0 percent.

(Continued)

TABLE 2

Test Results of Stone from Proposed Sources of Riprap (Continued)
Kaskaskia River, Illinois, Navigation Improvement

	Bulk Sp Gr SSD	Unit Wt, lb/cu ft	Absorp. %	L. A. Abrasion Loss, %	Toughness, Height, cm, Perpendicular to Joint Plane	Toughness, Height, cm, Parallel to Joint Plane	% Loss F&T in Alcohol and Water 20 Cycles
Bussen Quarry							
STL-19 G-4(A)							
(Ledge No. 1)							
Dense Limestone	2.61	162.6	1.6	26.6	7	9	0.4
STL-19 G-4(B)							
(Ledge No. 2)							
Dense Limestone	2.64	164.5	0.7	24.7	9	9	0.2
STL-19 G-4(C)							
(Ledge No. 3)							
Dense Limestone	2.61	162.6	1.1	28.4	9	8	0.8
Shaly Limestone	2.61	162.6	1.5	28.5	7	7	1.5
STL-19 G-4(D)							
(Ledge No. 4)							
Dense Limestone	2.62	163.2	0.7	28.9	7	8	0.2
Menefee Quarry							
VICKS-35 G-1(2)							
Danse Limestone	2.62	163.2	0.8	35.4	5	4	0.2

TABLE 2

Test Results of Proposed Sources of Concrete Aggregate
Kaskaskia River, Illinois, Navigation Improvement

	Bulk Sp Gr SSD	Absorp. %	Org. Imp. Fig. No.	Soft Particles, %	Flat and Elongated %	$MgSO_4$ Loss, %	Abrasion Loss, %	Freezing and Thawing in Concrete DFE 300
Gibbar Quarry No. 4								
STL-19 G-1								
1-1/2 - 3 in.	2.70	1.2	-	0.0	3.0*	-	30.8	-
3/4 - 1-1/2 in.	2.71	1.5	-	0.0	6.1*	-	34.6	-
No. 4 - 3/4 in.	2.71	1.4	-	0.0	5.3*	6.6	24.8	71
West Lake Quarry No. 5								
STL-19 G-2								
1-1/2 - 3 in.	2.68	0.6	-	2.9	9.3*	-	30.2	-
3/4 - 1-1/2 in.	2.67	0.8	-	3.6	14.0*	-	38.1	-
No. 4 - 3/4 in.	2.67	1.0	-	2.8	4.7*	13.4	29.7	80
Stotz Quarry								
STL-19 G-3								
1-1/2 - 3 in.	2.68	0.4	-	0.0	0.4	-	25.3	-
3/4 - 1-1/2 in.	2.68	0.5	-	0.6	1.6	-	32.6	-
No. 4 - 3/4 in.	2.68	0.7	-	0.0	2.9	2.8	43.9	81
Menefee Quarry								
VICKS-35 G-1(2)								
1-1/2 - 3 in.	2.62	1.0	-	7.1	0.8	-	43.8	-
3/4 - 1-1/2 in.	2.62	1.2	-	7.2	4.7	-	51.2	-
No. 4 - 3/4 in.	2.61	1.7	-	9.8	1.9	6.8	44.0	81

* Poor particle shape probably resulted from testing samples from crushed 6-in. cores.

(Continued)

TABLE 2

Test Results for Proposed Sources of Concrete Aggregate (Continued)
Kaskaskia River, Illinois, Navigation Improvement

	Bulk Sp Gr SSD	Absorp. %	Org. Imp. Fig. No.	Soft Particles, %	Flat and Elongated %	$MgSO_4$ Loss, %	Abrasion Loss, %
Southern Ill. Sand Co. STL-5 S-3(4)	2.63	0.4	5	-	-	-	-
Siegfried Fine Sand STL-19 S-1	2.61	1.2	3	-	-	-	-

Corps of Engineers, USAE Waterways Experiment Sta	Petrographic Report	Concrete Division P. O. Drawer 2131 Jackson, Mississippi
Project: Kaskaskia River, Illinois, Navigation Improvement		Date: 28 May 1965
Memo: 1441	Job: 441-6624	Initials: ADB, WIL, JH, KM

Samples

1. Samples of carbonate rocks from five quarries and two natural sands are listed and identified below:

CD Serial No.	Source	Type and Amount
STL-19		
G-1	Gibbar Quarry No. 4, near Red Rock, Mo.	6-in. core
G-2	West Lake Quarry No. 5, Little Rock Landing, near Ste. Genevieve, Mo.	Three 6-in. cores
G-3	Stotz Quarry, Prairie du Rocher, Ill.	Crushed stone
G-3(A)	Same - upper 13- and middle 10-ft ledge	Ledge rock
G-3(B)	Same - lower 14-ft ledge	Ledge rock
G-4(A)	Charlie Bussen Quarry, Ste. Genevieve, Mo.	Ledge No. 1
G-4(B)	Same	Ledge No. 2
G-4(C)	Same	Ledge No. 3
G-4(D)	Same	Ledge No. 4
VICKS-35		
G-1(2)	Menefee Quarry, Brickeys, Mo.	Ledge rock
STL-5		
S-3(4)	Southern Illinois Sand Co., Chester, Ill.	Natural sand
STL-19		
S-1	Siegfried Fine Sand, near Evansville, Ill.	Natural sand

Rock from all of the quarries except the Charlie Bussen Quarry, Ste. Genevieve, Mo., was tested as riprap and coarse aggregate. Rock from the Charlie Bussen Quarry was tested as riprap.

WES Form No. 1115
Rev. March 1964

Test Procedure

2. Core logs. Cores from Gibbar Quarry (STL-19 G-1) and West Lake Quarry No. 5 were logged. The surfaces were tested for differences in hardness and washed with dilute hydrochloric acid to emphasize lithologic changes. Samples of each lithologic variety were selected for test according to CRD-C 144, Method of Testing Stone for Resistance to Freezing and Thawing and for other riprap tests.

3. Ledge rock. STL-19 G-3(A), G-3(B), G-4(A) through G-4(D), and VICKS-35 G-1(2) were examined, using dilute hydrochloric acid and a steel needle to emphasize lithologic differences. Samples of each variety were selected for test according to CRD-C 144 and for other riprap tests.

4. Screening tests for dedolomitization reaction. Lithologic varieties in cores STL-19 G-1 and G-2, and in ledge rock STL-19 G-3(A) and (B), and the variety making up VICKS-35 G-1(2) were taken to determine whether alkali-carbonate reactive varieties were present. The screening tests consist of the following:

a. A representative sample of each lithologic variety was hand-ground and scanned on the diffractometer as a tight-packed powder. Samples consisting entirely of calcite or entirely of dolomite were eliminated from additional testing on the basis of these results.

b. If a variety had dolomite-calcite proportions in or near the reactive range, a sample was ground to pass No. 325 sieve. Each powder was compressed in an aluminum ring at 2000 lb; the compressed specimen was mounted

in the deffractometer and the relative intensities of the calcite and dolomite peaks were scaled. The intensity data were referred to the Tennant and Berger* curve to determine the amount of dolomite in the carbonate portion of each sample.

c. If dolomite was 30 to 70 percent of the total carbonate, and the rock was fine grained, cores approximately 1-1/4 in. long and 0.35 in. in diameter were drilled, shaped to have truncated conical ends, and prepared for length-change measurements during storage in 1-N NaOH.

d. If a variety was selected for length-change measurements, a representative weighed sample was dissolved in dilute hydrochloric acid. The weight of washed insoluble residue was determined and the insoluble residue was scanned on the diffractometer to determine its composition.

Petrographic examination

5. Menefee Quarry (VICKS-35 G-1(2)). Part of the ledge rock was crushed and processed to make aggregate in the size ranges No. 4 to 3/4-in., 3/4-to 1-1/2-in., and 1-1/2- to 3-in. A representative sample of each fraction was examined. The samples were washed and some particles were examined under the stereomicroscope before and after etching with dilute hydrochloric acid. The visual examination and stereomicroscope examination of the crushed aggregate confirmed the conclusion reached during the examination of the

* Tennant, C. B., and Berger, R. W., "X-Ray Determination of the Dolomite-Calcite Ratio of a Carbonate Rock," American Mineralogist, Vol 42, Nos. 1 and 2 (1957), pp 23-29.

ledge rock, that the sample could be treated as one lithologic variety; therefore, no particles counts of the crushed aggregate were made. X-ray diffraction patterns were made of a slab of fine grained rock, of a slab of the medium grained rock, and of a sample of the porous grayish-orange* dolomitic material that formed patchy areas in some of the rock. Two thin sections were made and examined, one from the opposite surface of the x-rayed slab of medium grained rock, and one from a piece containing porous dolomitic material. An immersion mount of calcareous chert was examined in an immersion oil of index of refraction 1.544 to determine whether the chert was chalcedonic.

6. Siegfried Fine Sand (STL-19 S-1). Representative parts of fractions retained on No. 100 and No. 200 sieves were examined under the stereomicroscope and tested with dilute hydrochloric acid to verify the presence of carbonate grains. Immersion mounts of each sieve fraction were prepared in immersion oil of refractive index 1.544, and at least 300 grains of each sieve fraction were classified and counted using a polarizing microscope.

7. X-Ray Diffraction Conditions. All X-ray scans were made on a diffractometer using nickel-filtered copper radiation at 27 KVCP and 41 ma or at 50 KVCP and 21 ma, as appropriate, with the rate meter setting at full scale equal to 0 - 4000 counts/sec.

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* The Rock-Color Chart Committee, National Research Council, Rock-Color Chart, Washington, D. C., 1948.

Results

7. Core from Gibbar Quarry (STL-19 G-1). Fig. 2 is the log of the core from this quarry. The rock from 37.5 ft to 118.3 ft was fairly similar in appearance and texture, although it varied in composition. The rock from 127.7 ft to 158.2 ft was more fractured than the rock from the upper ledge, and differed in texture from it. The rock in the footage between 37.5 ft and 118.3 ft -- the upper ledge -- was classified as follows:

Lithologic type	Footage	Percent of total
Dolomite	29.8 4.7 34.5	42.7
Dolomitic limestone	9.6	11.9
Slightly dolomitic limestone	36.7	45.4
Total	80.8	100.0

The rock in the footage from 127.7 to 158.2 was classified as follows:

Lithologic type	Footage	Percent of total
Dolomite	13.0 10.2 4.4 27.6	90.5
Shaly dolomite	2.5	8.2
Limestone	0.4	1.3
Total	30.5	100.0

The dolomite of the upper ledge was mottled tan to brownhish gray* dolomite

* Rock-Color Chart.

with chert nodules and seams resembling stylolites but composed of earthy dolomite. The mottled areas were softer than the matrix surrounding them. The dolomitic limestone and slightly dolomitic limestone, which were referred to as limestone in the riprap tests, contained closely spaced patches parallel bedding and areas resembling stylolites but composed of dolomite. All of the slabs tested according to CRD-C 144 from this core came from the upper ledge, because the abundance of vertical fractures and closely spaced bedding planes in the lower ledge did not permit obtaining slabs of adequate size for this test.

8. The rock from the lower ledge was predominantly dolomite, as the tabulation above shows, but it was predominantly fine grained hard massive dolomite with occasional paper-thin shale seams, some vuggy regions, a smaller proportion of mottled dolomite than in the upper ledge, and many vertical fractures.

9. The dolomite content of samples from various depths are shown below:

Depth, ft	Dolomite, Percent of Carbonate Portion
40.3 - 40.7	above 95
74.7 - 74.9	above 90
85.2 - 85.4	13
113.0 - 113.3	13
129.5 - 129.9	above 95
138.2 - 138.4	above 95
147.7 - 148.1	50 approx.

Except for the 3.5 ft of core represented by the last sample listed, dolomite contents fell outside the range in which deleterious dedolomitization reaction has been reported. Therefore, no additional screening tests of dedolomitization

potential were regarded as necessary.

9. West Lake Quarry No. 5 (STL-19 G-2). Three cores from this quarry -- cores WSG/1, WSG/1A, and WSG/1B -- are shown in fig. 3 through 5. WSG/1 is believed to represent the upper ledge, WSG/1A to represent the middle ledge and bottom ledge, and WSG/1B the lower ledge. Except for differences in amount of fracturing, the bottom of WSG/1A and WSG/1B are correlated, and thus the bottom of WSG/1A is believed to have penetrated the same rock as that represented by WSG/1B.

10. The lithologic varieties recognized in WSG/1, from 9.0 to 35.8 ft were:

Lithologic type	Footage	Percent of Total
Oolitic limestone	9.8	36.6
Massive dense limestone	11.6	43.3
Porous limestone	0.3	1.1
Shaly limestone or calcarous shale	1.7	6.3
Clay, core loss	3.4	12.7
Total	26.8	100.0

The oolitic limestone was light brownish-gray*, medium-grained, and dense. The massive dense limestone was brownish-gray* fine to medium grained usually fossiliferious and dolomitic in part, with some scattered chert. Brownish-gray* shaly limestone or dolomitic limestone contained many closely spaced shale scans and graded into calcareous shale. Except for a shaly zone from

* Rock-Color Chart.

about 24.0 to 26.5 ft, the rock was massively bedded. X-ray determinations of the dolomite content of samples from depths shown below gave the following results:

Lithologic variety*	Depth, ft	Dolomite
Oolitic	13.7	Not detected
Oolitic	14.6	Trace
Shaly	24.6	Not detected
Shaly	25.3	Not detected
Dense dolomitic	28.0	Not detected
Oolitic	30.5	Trace
Dense dolomitic	32.8	Not detected
Dense dolomitic	35.8	Not detected

* As identified during logging; the variations between non-dolomitic and partly dolomitic limestone were difficult to select visually.

The rock represented by this core should not be subject to dedolomitization if used as concrete aggregate. Oolitic limestone from this core was sampled for riprap tests.

11. The lithologic varieties recognized in cores WSG/1A and WSG/1B were:

Lithologic variety	WSG/1A[a]		WSG/1B[a,b]	
	ft	percent	ft	percent
Oolitic limestone	1.0	0.9		
Dense fine to medium-grained limestone (± fossils or chert)	50.5	46.5	3.1	20.7
Same as above but with scattered layers of shale	12.1	11.1		

(Continued)

(Continued)

Lithologic variety	WSG/1A[a] ft	WSG/1A[a] percent	WSG/1B[a,b] ft	WSG/1B[a,b] percent
Light gray fine-grained dense limestone with scattered chert nodules	11.0	10.1		
Gray medium-grained stylolitic limestone	6.8	6.3		
Sub-lithographic stylolitic limestone or dolomitic limestone	2.9	2.7	3.3	22.0
Fine to medium grained dolomitic limestone	23.0	21.2	8.1	54.0
Chert	0.6	0.6		
Shale	0.6	0.6	0.5	3.3
Total	108.5	100.0	15.0	100.0

(a) Hole WSG/1A represented material between 0.0 to 108.5 ft. The core from hole WSG/1B represented material from 0.0 to 15.0 ft. Elevations at tops of holes not given.

(b) The top 5 ft of this core was rubble. There were vertical fractures between 5.0 to 10.0 ft and between 14.0 to 15.0 ft.

12. Core WSG/1A. This core contained all of the lithologic varieties tested for riprap. In screening the core for potential alkali carbonate reaction, dolomite contents were determined as shown below. At four distributed depths where properties of dolomite and calcite indicated potential reactivity, the amount and nature of insoluble residue were determined and 0.35-in.-diameter cores were tested for length-change in 1-N NaOH. Determinations of dolomite content and of amount and type of insoluble residue appear below, and length-change determinations of cores from four depths are reported in table 1 and fig. 6.

Lithologic Variety	Depth, ft	Dolomite, %	Acid Insoluble Residue, %	Composition of Insoluble Residue
Dense cherty limestone	5.0	ND	-	-
Dense cherty limestone	14.3	ND	-	-
Dense cherty limestone	29.0	ND	-	-
Dense cherty limestone	40.0	ND	-	-
Dolomite	51.0	$\geq$95	-	-
Dense dolomitic limestone	55.0	53	2.5	Clay-mica, quartz
Dolomite	57.0	$\geq$95	-	-
Dolomite	58.5	$\geq$95	-	-
Dense limestone	64.0	ND	-	-
Dense limestone	69.0	ND	-	-
Soft dolomitic limestone	90.0	53	4.2	Clay-mica, quartz
Soft dolomitic limestone	94.0	64	5.0	Clay-mica, quartz
Dense dolomitic limestone	100.5	50 approx	-	-
Dense dolomitic limestone	102.0	53	-	-
Dense dolomitic limestone	102.8 - 103.0	50 approx	-	-
Dense dolomitic limestone	103.5	50 approx	-	-
Dense dolomitic limestone, sublithographic	103.9	53	3.2	Clay-mica, quartz, kaolin
Dense limestone	104.5	ND	-	-
Dense limestone	107.0	ND	-	-

The expansions up to 28 days of the cores from depths 90 to 103.9 ft indicate that it would probably produce an expansive reaction in concrete in which it was used as aggregate.

13. Core WSG/1B. This core was described as representing the lowest working ledge, but while its thickness was reported as over 35 ft, only 15 ft of core was received, of which the top 10 ft was rubble and highly fractured rock. Rock of the core was very much like rock in WSG/1A in the depths below 90 ft. X-ray determinations of dolomite content in rock from depths 2.5, 5.8, 9.5, 10.0, 13.9, and 14.0 - 14.5 ft all indicated about 50 percent dolomite.

14. Stotz Quarry (STL-19 G-3(A); 3(B)). Ledge rock samples STL-19 G-3(A), representing the upper 13-ft and middle 10-ft ledges, and STL-19 G-3(B), representing the lower 14-ft ledge in the quarry were examined. None of the rock contained calcite-dolomite proportions regarded as dangerous.

a. STL-19 G-3(A). The sample consisted of 14 tabular and pyramidal pieces ranging from 10 by 7 by 6 in. to 15 by 12 by 6 in., with the average about 12 by 10 by 8 in. The rock was pale yellowish-brown*, fine to medium-grained limestone which graded into fine-grained oolitic limestone. Four blocks contained enough shaly seams and stylolites to be called shaly limestone. The riprap tests were made on two varieties, dense limestone and shaly limestone.

b. STL-19 G-3(B). The 14 pieces of this sample resembled STL-19 G-3(A)

* Rock-Color Chart.

in size, shape, and composition, but did not contain shaly limestone. The riprap tests were made on dense limestone only.

15. Bussen Quarry (STL-19 G-4(A) through G-4(D)). The sample from this quarry consisted of 14 ledge-rock blocks from Ledge 1 (G-4(A)), 16 from Ledge 2 (G-4(B)), and 20 each from Ledge 3 (G-4(C)) and Ledge 4 (G-4(D)), for riprap tests. The sizes of blocks ranged from 7 by 7 by 4 in. to 14 by 9 by 7 in., with the average about 13 by 7 by 5 in.

a. Blocks from Ledge 3 were all tabular, but those from the others included some blocky and some tabular. The sample from Ledge 1 included some blocks with partial rusty coatings. Part of the blocks were light olive-gray*, fine-grained oolitic limestone like part of the sample from the Stotz Quarry (STL-19 G-3(A)). The rest was moderate yellowish-brown*, fine-grained dolomitic limestone; this rock contained many fossil fragments recrystallized to single crystals. Riprap tests were made on one variety, dense limestone.

b. Rock from Ledge 2 was pale yellowish-brown*, dense limestone with single crystal fossil fragments in a fine-grained matrix that contained more stylolites than rock of Ledge 1. Riprap tests were made on one variety, dense limestone.

c. Ledge 3 was represented by 16 blocks of dense limestone and 4 of shaly limestone. The rock was generally similar to that from Ledge 2, but was lighter in color, finer-grained, and contained fewer single crystal fossils. Riprap tests were made on two varieties, shaly limestone and dense limestone.

d. Ledge 4 was represented by 19 blocks of dense and 1 of shaly

* Rock-Color Chart.

limestone. Most of the blocks had partial clay coatings. The rock was light olive-gray*, fine grained, and somewhat oolitic like part of the rock from Ledge 1.

17. Menefee Quarry (VICKS-35 G-1(2)). There were about 200 pieces of medium-grained limestone ledge rock in this sample. Most of the pieces were blocky, and about 12 by 11 by 6 in. in size, with a size range from 8 by 6 by 5 in. to 21 by 12 by 10 in. Most of the blocks were yellowish-gray* with about one-quarter of the blocks light olive-gray* with scattered regions of soft grayish-yellow* porous rock; there were a few light olive-gray* blocks. The sample was regarded as one variety for riprap tests; all the slabs tested according to CRD-C 144 were the yellowish-gray* variety.

18. After the samples for riprap tests had been chosen, the remainder was crushed to produce aggregate of 3-in. maximum size. The particle shape was blocky with well-rounded corners and edges in the larger sizes, with tabular pieces increasing in the smaller sizes. All of the color variations were expected to behave alike in concrete.

19. The yellowish-gray* limestone making up most of the sample included two varieties. The predominant one was medium-grained limestone made up of anhedral calcite grains, containing many small discrete voids which were responsible for the low bulk specific gravity of the rock. Part of the rock was highly fossiliferious and contained vugs partially filled with calcite crystals; some contained limonitic stylolites or had limonitic surface coatings. The minor variety was fine-grained dense limestone which contained

* Rock-Color Chart.

about 10 percent dolomite, a small amount of quartz grains and chert, and occasional black stylolites.

20. The light olive-gray* limestone was like the medium-grained yellowish-gray* limestone but contained iron oxides, including limonitic stylolites and limonite disseminated through the rock. Soft powdery red hematite coated surfaces and also was disseminated through the rock.

21. The light olive gray* fine-grained limestone contained scattered regions of soft porous orange material composed of dolimite with calcite, chert, and clay mica, and inconspicious regions of calcareous chert. The chert was not chalcedonic.

22. The varieties in this sample were recrystallized calcarenites, showing differing amounts of recrystallization, possibly related differences in grain size, and various concentrations of iron oxide.

23. Siegfried Fine Sand (STL-19 S-1). The sample was a clean quartz sand (table 2); all passed the No. 50. sieve.

a. Quartz. Quartz was the major constituent in irregular or block grains with angular edges. Some of the grains were well-rounded blockly particles.

b. Chert. Chert, including some with an index of refaction below 1.544, made up 10 percent of the sand.

c. Feldspar. Fresh and altered plagioclase and potassium feldspar were minor constituents.

* Rock-Color Chart.

d. Miscellaneous. Micas-muscovite, biotite, glauconite, carbonate fragments, green hornblende, and garnet grains, and other mineral and rock grains were classified here.

Summary

Riprap

24. A 6-in.-diameter core from Gibbar Quarry No. 4 (STL-19 G-1) and three 6-in.-diameter cores from West Lake Quarry No. 5 (STL-19 G-2) were logged (fig. 1 through 4). Ledge rock samples from Stotz Quarry (STL-19 G-3(A), (B)), Charlie Bussen Quarry (STL-19 G-4(A) through (D)), and Menefee Quarry (VICKS-35 G-1(2)) were examined. Important lithologic varieties in each sample were chosen for physical tests. The bedding of all the limestone was thick enough to allow production of blocks large enough for riprap. Rock from the Menefee Quarry (VICKS-35 G-1(2)) and Bussen Quarry (STL-19 G-4(A) through (D)) were least affected by freezing and thawing (CRD-C 144).

Coarse aggregate

25. All of the samples tested as riprap, except STL-19 G-4(A) through (D) from Bussen Quarry, were considered as coarse aggregate. Screening tests were made of all four to detect rock capable of the dedolomitization reaction in concrete. Rock from depths of 90 through 104 ft in core WSG/1A, West Lake Quarry No. 5 (STL-19 G-2) contained proportions of dolomite in the reactive range and expanded where stored in 1-N NaOH (table 1, fig. 5). Rock from this zone probably represents the top of the lower 35-ft ledge. If all three ledges were simultaneously quarried, the resulting aggregate would probably not be expansive in concrete. Rock from the other sources considered as coarse aggregage did not contain dolomite proportions in the reactive range.

Fine aggregate

26. The fine blending sand (STL-19 S-1) contained 10 percent chert, including some chalcedonic chert. If the sand were used in amounts such that chert amounted to 5 percent of the fine aggregate, low alkali cement should be specified to avoid the possibility of deleterious alkali silica reaction.

8 Incl
1-2. Tables
3-8. Figures

Table 1

Length Change; Limestone Cores (STL-10 G-2)

Depth, ft	Lithologic Variety	Specimen No.	Percent Length Change at Ages Below[a] 7	14	21	28	56
55	Dense dolomitic limestone	1	-0.015	-0.008	-0.030	-0.030	-0.046
		2	-0.016	-0.023	-0.031	-0.039	-0.031
90	Soft dolomitic limestone	1	0.032	0.024	0.024	0.056	0.056
		2	0.066	0.088	0.081	0.081	0.110
94	Soft dolomitic limestone	1	0.047	0.055	0.047	0.055	0.078
		2	0.043	0.007	0.021	0.093	0.100
103.9	Dense dolomitic limestone	1	0.049	0.082	0.066	0.115	0.140
		2	0.079	0.165	0.197	0.221	0.291

(a) Shrinkage is indicated by a minus sign.

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Table 2

Composition of Siegfried Fine Sand (STL-19-S-1)
from Ruma Asphalt Co., Ruma, Ill.

Constituents	Amount in Fractions Retained on Sieves Shown Below, Percent[a]		Weighted Average Composition[b]
	No. 100	No. 200	
Quartz	68	75	74
Chert	14	9	10
Feldspar	7	6	6
Miscellaneous[c]	11	10	10
Total	100	100	100

(a) Based on examination of 300 or more particles in sieve sizes above.

(b) Calculated from the grading and the composition of sizes shown. Material passing No. 22, 7.3 percent, was included with the No. 200 material in calculation.

(c) Includes micas, carbonates, hornblende, garnet, and various other rocks and minerals.

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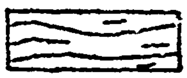
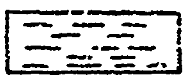
Legend for Core Logs

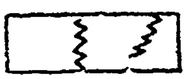
Dense limestone or dolomite.



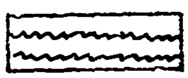
Limestone or dolomite with shale laminations or occasional shaly streaks.



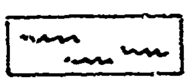
Shale or very shaly limestone.



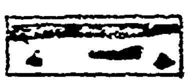
Limestone or dolomite containing vertical or diagonal fractures.



Limestone or dolomite containing stylolites.



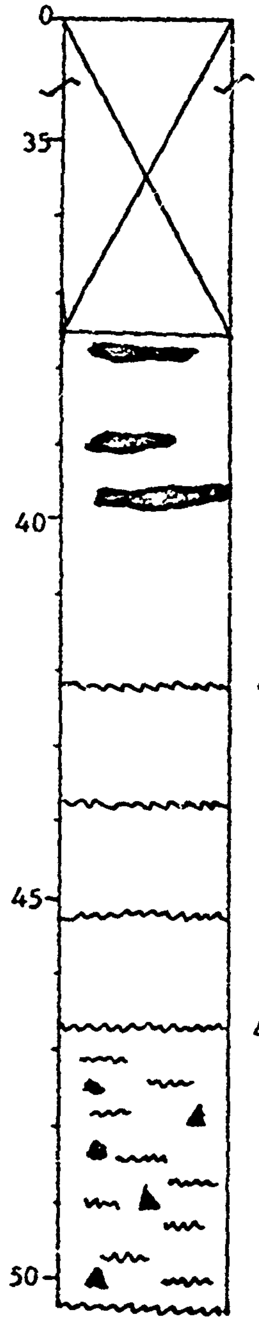
Limestone or dolomite containing short stylolite-like patches or seams.



Limestone or dolomite containing chert nodules or seams.

Figure 1

Gibbar Quarry No. 4
Red Rock, Missouri
(STL-19 C-1)



0.0 - 37.5	Not sent.
37.5 - 40.8	Brownish-gray and tan mottled dolomite with large lenticular brown to gray chert nodules. Chert nodules up to 2 in. thick and cover considerable amount of cored surface.
40.8 - 42.1	Gray-brown and tan mottled dolomite. Tan mottling has earthy texture and is softer than gray portion of rock, massively bedded.
42.1 - 46.8	As above, becoming somewhat stylolitic. Less mottling in bottom foot (45.8 - 46.8).
46.8 - 50.5	Brownish-gray dense, somewhat mottled and cherty dolomite with closely spaced, short discontinuous, horizontal-lying patches and stylolite-like planes composed of earthy-textured, somewhat weathered dolomite. Becomes more weathered and vuggy from 49.4 - 50.5 ft.

Figure 2

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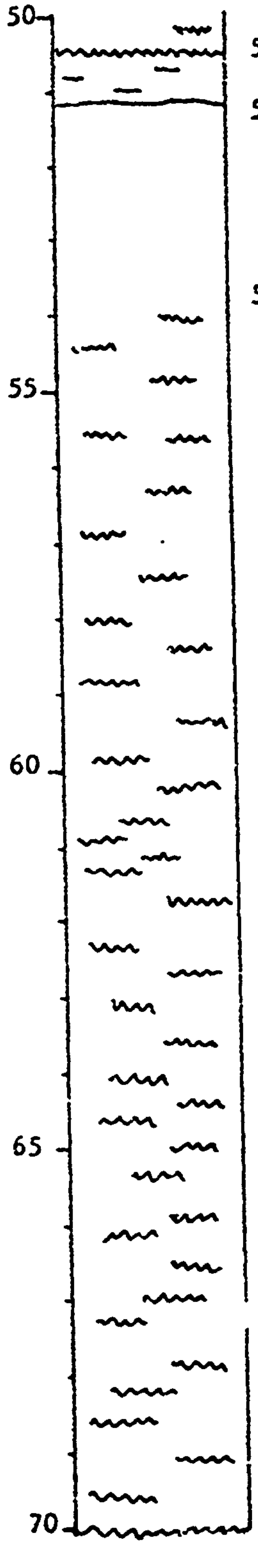
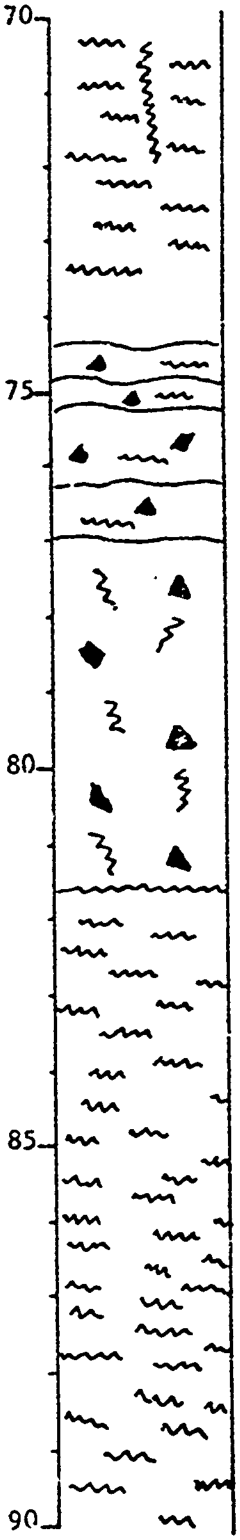
Gibbar Quarry No. 4



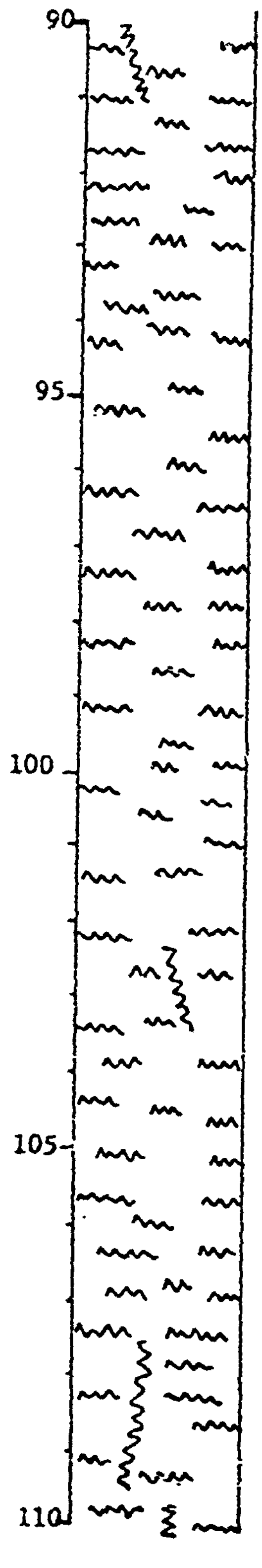
50.5 - 51.1	Light brownish-gray silty dolomite, thin bedded.
51.1 - 53.1	Brownish-gray, mottled dolomite. Mottled portion of rock stained, appears weathered, more porous than rest of rock.
53.1 - 67.3	Brownish-gray dolomite with short, discontinuous, horizontal lying patches and stylolite - like seams as in interval from 46.8 - 50.5 ft. - Iron staining along seams. Occasional small vugs in zone from 56.1 - 61.5 ft, some vugs filled with soft, white material, probably gypsum.
67.3 - 70.0	Grades into brownish-gray fine to medium-grained dolomite limestone with tan mottling in stylolite-like seams as above.

Gibbar Quarry No. 4



70.0 - 71.4	Dolomitic limestone as above. Diagonal fracture from 70.0 - 71.8 ft.
71.4 - 76.9	Dense dolomitic limestone with stylolite-like planes in 71.4 - 72.4 interval grading into dense dolomite from 72.4 - 74.3 ft, then grading into fine-grained dolomitic limestone with thin, shaly stylolites. Tan to white chert nodules from 74.9 - 76.9 ft.
76.9 - 81.6	Brownish-gray fine to medium grained dolomite with scattered chert nodules. Rock contains many short, diagonal and vertical fractures, most of which are re-sealed with clear calcite. Thin zone (0.1 ft thick) of weathered limestone at 81.0 ft.
81.6 - 90	Light to medium gray, very fine-grained, dense, fossiliferous, slightly dolomitic limestone containing closely spaced, mostly horizontal lying patches and stylolite-like seams composed of dolomite throughout entire interval.

Gibbar Quarry No. 4



90 - 110

Light gray to medium-gray fine-grained limestone with patches and stylolite-like seams composed of dolomite as above, vertical fracture from 90 - 91 ft.

Vertical fracture from 102.1 - 103.3 ft.

Vertical fracture with 1-in. thick coarsely crystalline white calcite lining; 107.6 - 109.6 ft.

4

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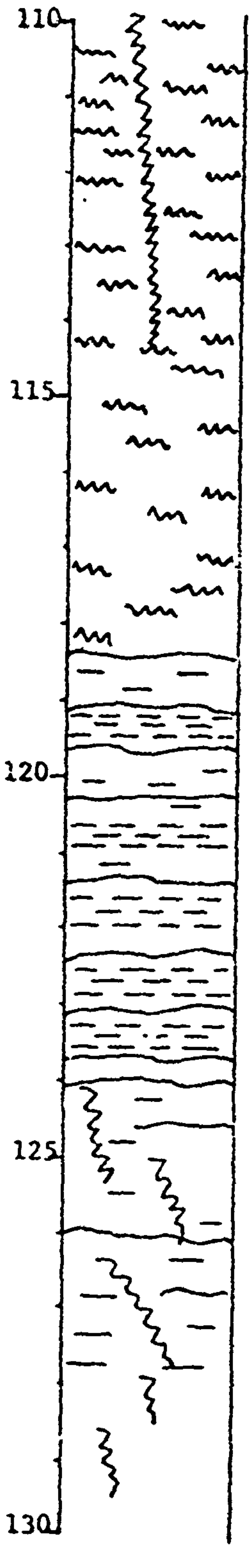
Gibbar Quarry No. 4



110.0 - 118.3

Limestone with dolomitic stylolite-like seams and patches as above. Vertical fracture, 109.6 - 114.3 ft.

118.3 - 124.0

Alternating thin beds of greenish-gray shaly limestone, limestone, and shale.

Note: Interval from 118.3 to 127.7 ft represented material between the two quarried ledges that is wasted.

124.0 - 127.7

Highly fractured sandy, shaly limestone or dolomite.

127.7 - 131.0

Brownish-gray, hard, massively bedded, fine-grained dolomite with small, paper thin blotches of greenish-gray pyrite in upper two ft. Entire section fractured and resealed with calcite.

5

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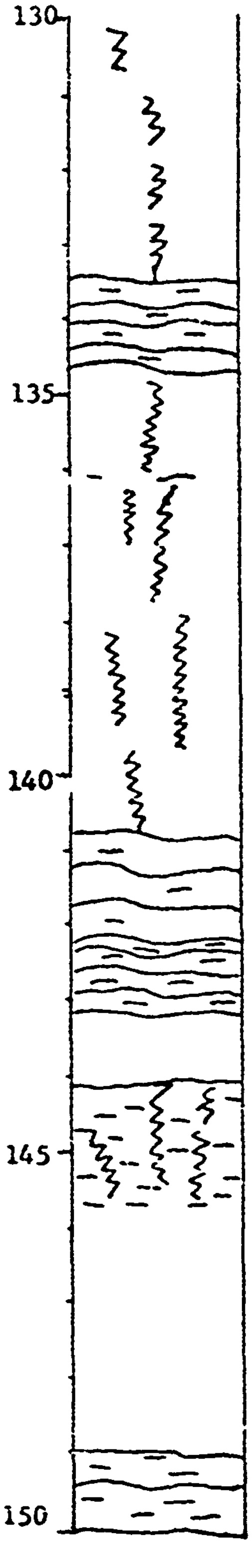
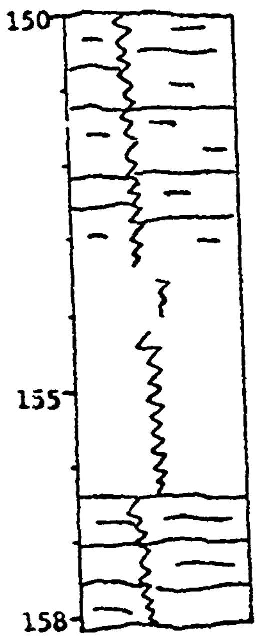
Cibbar Quarry No. 4



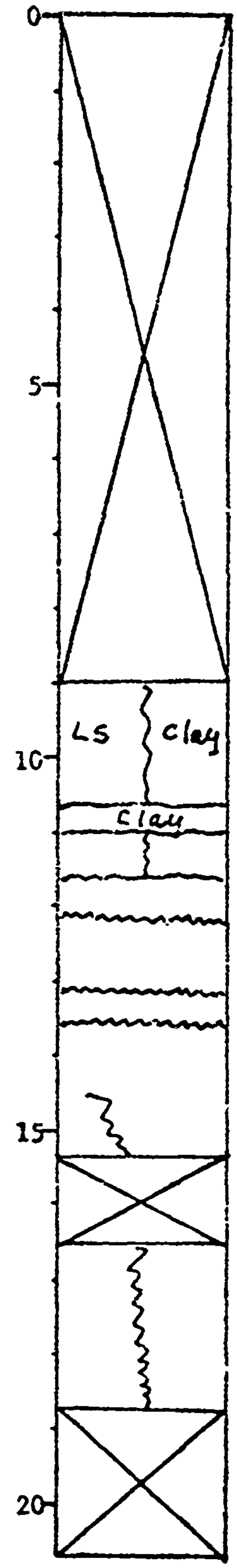
130.0 - 131.0	As above
131.0 - 133.0	Hard, brownish-gray dolomite as above, fractures resealed with calcite, scattered small vugs throughout interval.
133.C - 133.5	As above, except weathered reddish-brown on fractures.
133.5 - 134.5	Hard, brownish-gray shaly dolomite. Paper-thin shaly seams.
134.5 - 136.1	Hard, brownish-gray dolomite. Vuggy, fractured, fractures partially resealed.
136.1 - 137.7	As above, except highly fractured.
137.7 - 139.6	Weathered and vuggy fractured dolomite, some fractures resealed with calcite.
139.6 - 140.7	Brownish-gray earthy-textured dolomite, weathered on vertical fractures.
140.7 - 143.2	Brown and gray-brown mottled, shaly, vuggy, weathered dolomite. Very shaly 142.2 - 143.2 ft.
143.2 - 144.1	Brownish-gray and tan mottled, dense dolomite.
144.1 - 145.6	Brownish-gray highly fractured shaly dolomite, weathered on fractures.
145.6 - 146.0	Hard, brownish-gray vuggy dolomite.
146.0 - 148.9	Hard, light gray to brownish-gray dense limestone with dolomitic patches and stylolite-like seams.
148.9 - 149.4	As above, with shaly streaks.
149.4 - 150.0	Brownish-gray earthy-textured shaly dolomite.

Gibbar Quarry No. 4



150.0 - 153.4	Light brownish-gray earthy-textured, shaly, fractured dolomite, weathered along fractures.
153.4 - 153.8	Light gray, dense, fine-grained limestone, fractures sealed with calcite.
153.8 - 156.4	Brownish-gray to dark gray mottled dense dolomite. Vertical fractures along entire length.
156.4 - 158.2	As above, except contains thin shale laminations.
158.2	End of core.

West Lake Quarry No. 5
Hole WSG/1
(STL-19 G-2)



0 - 9.0 Not sent.

9.0 - 11.5 Light brownish (tan) massively bedded oolitic limestone with vertical fracture along entire length. Material on one side of fracture is limestone, on other side material is reddish brown calcareous soil-clay. Core shows evidence of solution along fracture, probably from water moving in a horizontal direction. Soil-clay seam 10.7 - 11.0 ft.

11.5 - 15.3 Tan, massively bedded oolitic limestone with occasional stylolites. Stylolites at 12 2, 13.2, 13.5 ft. Fractured from 14.6 - 15.3-ft with evidence of solution along fracture.

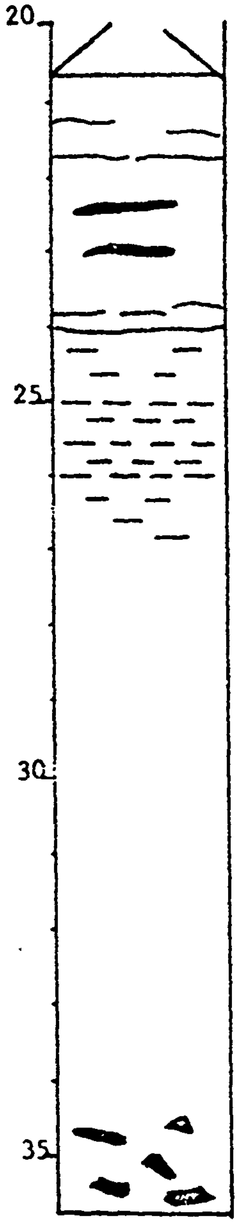
15.3 - 16.5 No recovery - Note on box says "Clay washed away."

16.5 - 18.7 Oolitic limestone as above. Fractured; solution evidence along fracture.

18.7 - 20.6 No recovery; Note on box says "Clay washed away."

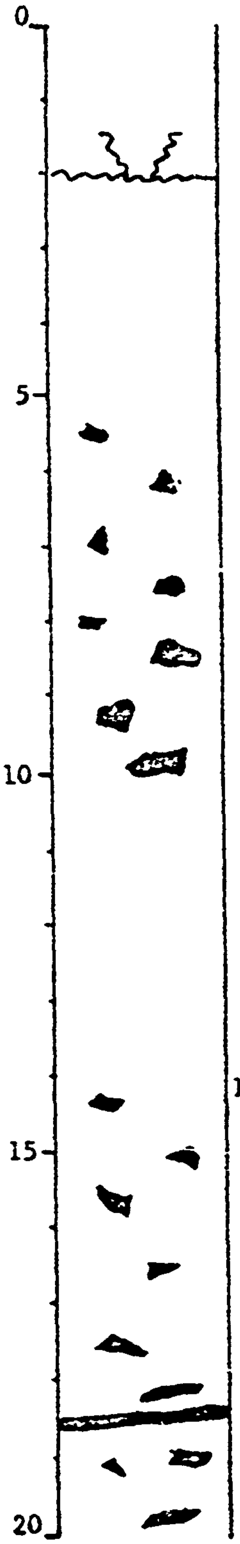
Figure 3

West Lake Quarry No. 5
Hole No. WSG-1



20.6 - 21.5	Oolitic limestone as above, with few very thin shaly streaks.
21.5 - 24.0	Limestone grades into massive brownish-gray, medium-grained dense limestone with thin shale laminations from 23.8 - 24.0 ft. Lenticular chert nodules at 22.4 and 23.0 ft.
24.0 - 24.3	Soft, porous, light gray limestone.
24.3 - 25.0	Greenish-gray limestone with high disseminated shale content.
25.0 - 26.0	Grades into calcareous shale.
26.0 - 30.3	Gray fine-grained limestone containing disseminated shale in upper foot grading into fine to medium-grained brownish-gray fossiliferous limestone.
30.3 - 31.0	Grades into oolitic limestone.
31.0 - 35.8	Grades back into massive light brownish-gray fine-grained fossiliferous limestone. Chert nodules from 34.4 - 35.8 ft.
35.8	End of core.

West Lake Quarry No. 5
Little Rock Landing, Missouri
Hole WSG/1A
(STL-19 G-2)

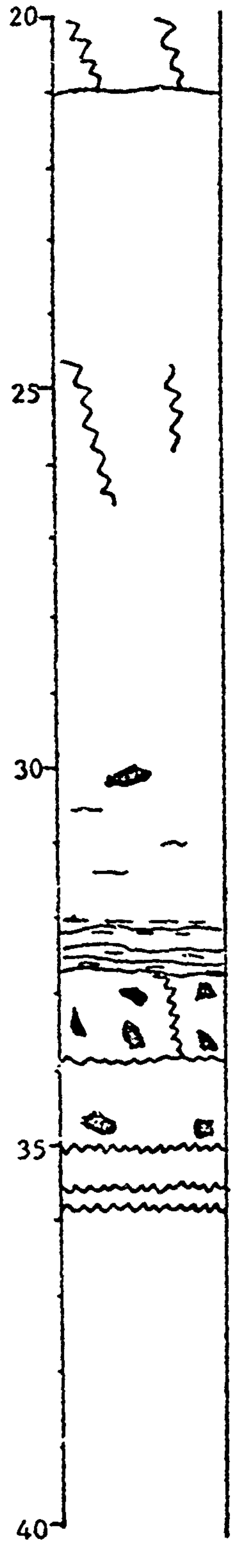


0.0 - 1.0	Light brownish-gray, dense, medium-grained oolitic limestone.
1.0 - 5.0	Dense, massively bedded, brownish-gray, fine to medium-grained fossiliferous limestone. Fractured from 2.5 - 3.0 ft.
5.0 - 14.2	As above, with black chert nodules up to 3 in. in diameter in zone from 5.0 - 9.8 ft.
14.2 - 20.0	Dense, massively-bedded, brownish-gray, fine-grained fossiliferous limestone with occasional chert nodules. Chert band 0.1 ft thick at 18.5 ft.

Figure 4

30

West Lake Quarry No. 5
Hole WSG/1A



20.0 - 30.3 Dense, massively-bedded, fine to medium-grained, gray to brownish-gray, fossiliferous limestone. Fractures from 19.9 - 21.0 ft and 24.6 - 26.7 ft. Chert nodule at 30.2 ft.

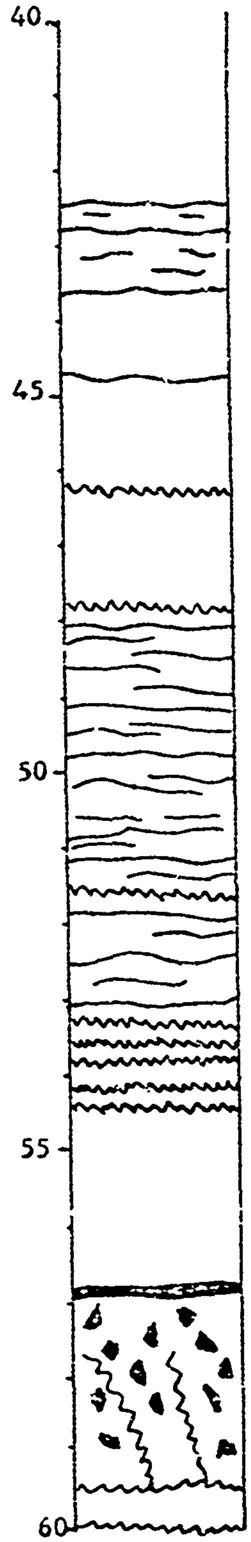
30.3 - 32.0 As above, except containing zones of disseminated shale.

32.0 - 32.6 Gray shaly limestone with numerous shale laminations.

32.6 - 33.8 Light gray fine-grained dense limestone with tan chert nodules. Fractured, 32.6 - 33.8 ft.

33.8 - 40.0 Light brownish-gray, medium-grained dense limestone with stylolites at 35.1, 35.6, and 35.8 ft. Chert nodules at 34.9 ft. Limestone may be slightly porous.

West Lake Quarry No. 5
Hole WSG/1A

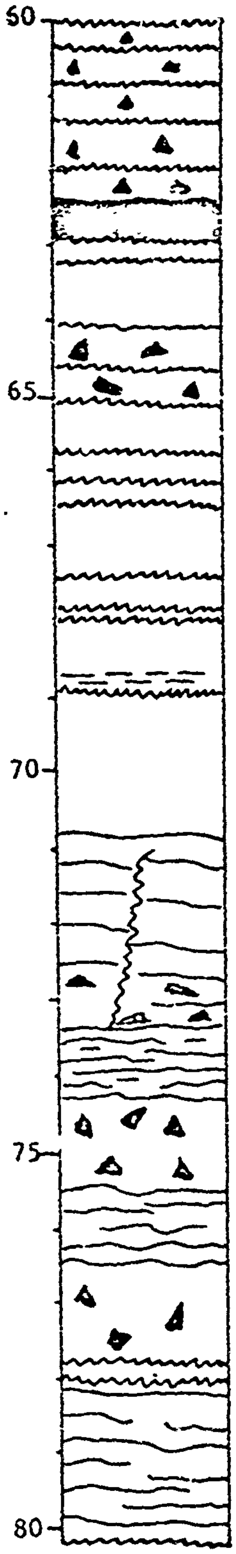


40.0 - 42.4	Light brownish-gray medium-grained limestone as above.
42.4 - 43.6	As above, but with thin shale laminations.
43.6 - 44.7	Light brownish-gray dense medium-grained limestone.
44.7 - 53.3	Brownish-gray, fine-grained limestone with numerous thin shale laminations and a few stylolites.
51.0	Small zone of dolomite.
53.3 - 54.5	Gray, medium-grained stylolitic limestone.
54.5 - 56.2	Brownish-gray, dolomitic limestone becoming progressively softer down to 56.2 ft.
56.2 - 56.6	Soft, weathered dolomitic limestone.
56.6 - 59.4	Brownish-gray dolomitic limestone and calcareous dolomite with numerous chert nodules. Fractured from 57.5 - 58.8 ft.
59.4 - 62.3	Light brownish-gray sublithographic stylolitic limestone.

3

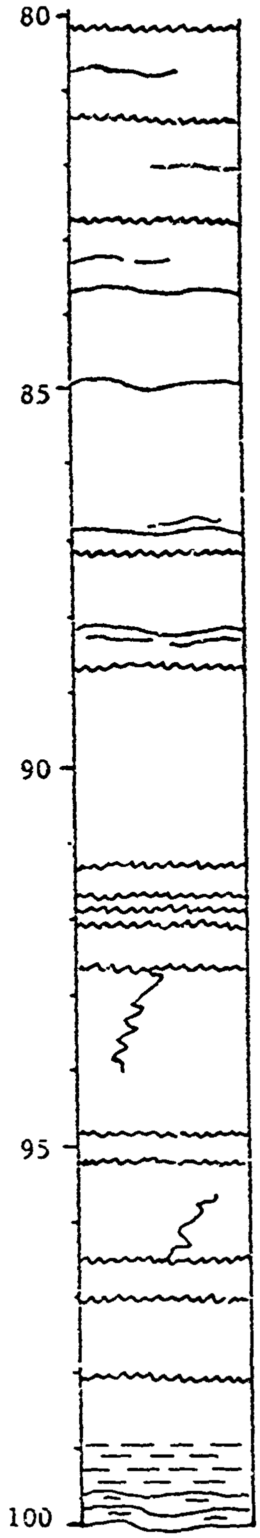
3V

West Lake Quarry No. 5
Hole WSG/1A



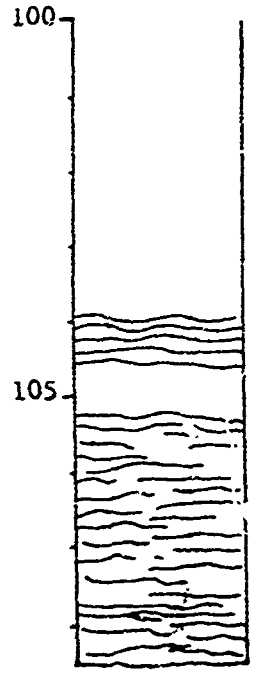
59.4 - 62.3	Light brownish-gray sublithographic dense limestone with fairly open stylolites every 3 to 6 in. Tan to gray chert nodules over entire zone.
62.3 - 62.9	Hard, brownish-gray chert.
62.9 - 64.0	Brownish-gray dense, medium-grained limestone, stylolites at 62.9 - 63.1 ft.
64.0 - 65.2	As above except finer grained and containing chert nodules.
65.2 - 70.8	Dense medium gray, medium-grained stylolitic limestone. Stylolites at 65.2, 65.7, 66.2, 66.4, 67.4, 67.8, 67.9, 68.8; 1/2-in. shale streak at 68.5 ft. Vertical fracture from 68.6 to 70.8 ft.
70.8 - 74.2	Brownish-gray, fine-grained limestone with thin shale laminations every few inches. Very shaly from 73.4 to 74.4. Chert nodules from 72.4 - 73.4. Fractured from 70.8 - 73.4
74.2 - 75.4	Dense medium-grained limestone with chert nodules.
75.4 - 76.4	Brownish-gray fine-grained limestone with thin shale laminations.
76.4 - 78.2	Brownish-gray medium-grained limestone with few chert nodules stylolites at 77.8, 78.0 ft.
78.2 - 80.2	Brownish-gray, medium grained limestone with thin shale laminations.

West Lake Quarry No. 5
Hole WSG/1A



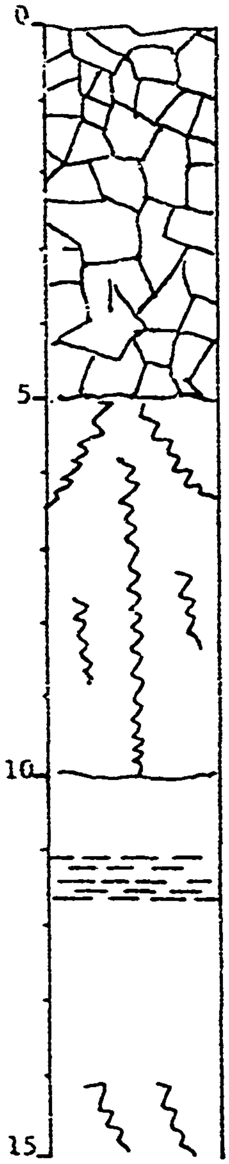
80.2 - 83.7	Medium-grained, light brownish-gray dense limestone with occasional shaly streaks and stylolites. Fractured 81.4 - 81.7 ft.
83.7 - 84.9	Yellowish-gray fine-grained earthy-textured, porous, softer, dolomitic limestone.
84.9 - 89.0	Light brownish-gray medium grained dense limestone; soft streak from 85.8 - 85.9; stylolites at 87.2 and 88.7; shaly streaks at 86.9 and 88.2.
89.0 - 91.3	Limestone grades back into the yellowish-gray, soft, earthy-textured, dolomitic variety. No shale or stylolites.
91.3 - 92.9	Dense, brownish to yellowish-gray medium-grained limestone with stylolites at 91.3, 91.6, 91.8, 92.0, 92.6 ft.
92.9 - 94.8	Limestone grades back to yellowish-gray, softer, medium-grained to earthy-textured dolomitic variety. Fractured from 92.9 - 94.0 ft.
94.8 - 99.0	Tan to brownish-gray medium-grained dense dolomitic limestone; stylolites at 94.8, 95.2, 96.5, 97.0, 98.1 ft. Fractured from 95.6 - 96.5 ft.
99.0 - 99.6	Dark gray "poker chip"shale.
99.6 - 100.0	Gray, fine-grained shaly limestone.

West Lake Quarry No. 5
Hole WSG/1A



100.0 - 103.9	Light gray, hard, dense, very fine grained to sublithographic limestone and dolomitic limestone, massively bedded.
103.9 - 108.5	Light gray, hard, dense, sublithographic limestone and dolomitic limestone with thin shale laminations. Shale at 103.9, 104.0, 104.1, 104.3, 104.6, 105.3, 105.4, and 105.8 and more numerous below.
108.5	End of core.

West Lake Quarry No. 5
Hole WSG/1B
(STL-19 G-2)



0.0 - 1.3	Broken rubble composed of hard, light brownish-gray, medium-grained limestone.
1.3 - 3.2	Broken rubble composed of soft, porous, earthy-textured, yellowish-gray, dolomitic limestone.
3.2 - 5.0	Rubble consisting of hard limestone as in 0.0 - 1.3 ft interval.
5.0 - 6.1	Highly fractured, yellowish-gray soft earthy-textured dolomitic limestone.
6.1 - 10.0	Limestone grades into hard, medium-grained, brownish-gray massively-bedded dolomitic limestone. Vertical fracture throughout entire interval.
10.0 - 11.2	As above, but becoming finer grained with increasing depth.
11.2 - 11.7	Greenish-gray "poker chip" shale.
11.7 - 15.0	Light brownish-gray, massively-bedded hard, sublithographic dolomitic limestone. Fractured from 14.0 - 15.0 ft.
15.0	End of core.

Figure 5

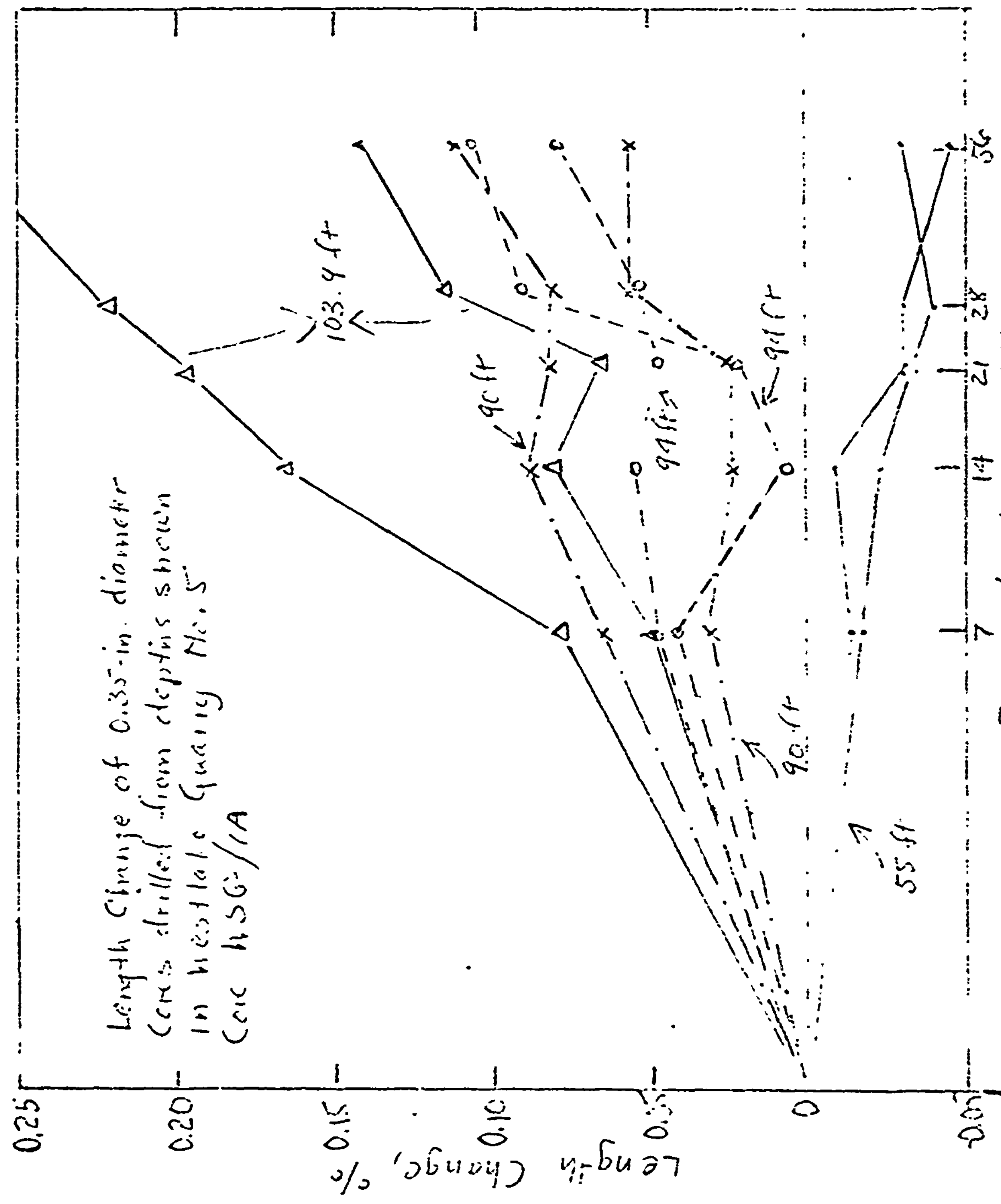

Length Change of 0.35-in. diameter
Length Change, %
0.25
0.20
0.15
0.10
0.05
0
-0.05
Days In 1-N NaOH
7
14
21
28
56
103.4 ft
90 ft
91 ft
91 ft
90 ft
55 ft

Figure 6

STATE: Missouri	INDEX NO.:	RIPRAP DATA SHEET	TESTED BY: USAEWES
LAT.: 37	LONG.: 89		DATE: May 1965

LAB. SYMBOL NO.: STL-19 G-1 TYPE OF MATERIAL: 6-in. core

LOCATION: Sec 11, R 12 E, T 35 N, Perry County, Missouri, near Red Rock, Missouri

PRODUCER: Southern River Rock Co., Box 33, Perryville, Missouri

SAMPLED BY: St. Louis District

TESTED FOR: Kaskaskia River, Illinois, Navigation Improvement

PROCESSING BEFORE TESTING:

GEOLOGICAL FORMATION AND AGE:

GRADING (CRD-C 103)(CUM. % PASSING):

SIEVE	3-6"	1½-3"	¾-1½"	#4-¾"	FINE AGG.
6 IN.					
5 IN.					
4 IN.					
3 IN.					
2½ IN.					
2 IN.					
1½ IN.					
1 IN.					
¾ IN.					
½ IN.					
⅜ IN.					
NO. 4					
NO. 8					
NO. 16					
NO. 30					
NO. 50					
NO. 100					
NO. 200					
- 200[a]					
F.M.[b]					

(a) CRD-C 105 (b) CRD-C 104

TEST RESULTS

	3-6"	1½-3"	Limestone	Dolomite	FINE AGG.
BULK SP. GR., SAT. SURF. DRY (CRD-C 107,108):			2.69	2.68	
ABSORPTION, PER CENT (CRD-C 107,108):			0.4	1.7	
ORGANIC IMPURITIES, FIG. NO. (CRD-C 121):	—	—	—	—	
SOFT PARTICLES, PER CENT (CRD-C 130):					—
PER CENT LIGHTER THAN SP. GR. ____ (CRD-C 129):					—
PER CENT FLAT AND ELONGATED (CRD-C 119,120):					
WEIGHTED AV. % LOSS, 5 CYC. $MgSO_4$ ((c) ½-1", #4-½) (CRD-C 115)					
ABRASION LOSS (L. A.), %, (CRD-C 117):			28.5	20.0	—
UNIT WT., LB/CU FT (CRD-C 107):			167.6	167.0	
Toughness (CRD-C 132):			7/5*	7/7*	
COAL AND LIGNITE, % (CRD-C 122):	—	—	—	—	
SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):					
REACTIVITY WITH NaOH (CRD-C 128): Sc, mM/L					
Rc, mM/L					

MORTAR-MAKING PROPERTIES (CRD-C 116)

TYPE____ CEMENT, RATIO____ DAYS,____ %,____ DAYS,____ %

LINEAR THERMAL EXPANSION X10⁻⁶/DEG. F. (CRD-C 125,126):

ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE

MORTAR:

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):	FINE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.	COARSE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK. CEMENT: % Na_2O EQUIVALENT:								
HIGH-ALK. CEMENT: % Na_2O EQUIVALENT:								

SOUNDNESS IN CONCRETE (CRD-C 40, 114):			F & T	HW-CD	HD-CW
FINE AGG. STL-5 S-3(4) STL-19 S-1	COARSE AGG.: STL-19 G-1	DFE_{300}	71		
FINE AGG.	COARSE AGG.:	DFE_{300}			

PETROGRAPHIC DATA (CRD-C 127):

REMARKS: * The number to the left is the height of the blow at failure in cm perpendicular to the structural weakness and the number to the right is the height of the blow parallel to the structural weakness of the sample.

WES FORM 726 JAN. 1951

Corps of Engineers, USAE	Riprap Data Sheet	Concrete Division P. O. Drawer 2131 Jackson, Mississippi

Project
Kaskaskia River, Illinois, Navigation Improvement

Date
May 1965

STL-19 G-1 (6-in. Core) Gibbar Quarry No. 4

Toughness. (CRD-C 132):

Test No.	Height of Blow at Failure, cm			
	Perpendicular to Plane of Structural Weakness		Parallel to Plane of Structural Weakness	
	Limestone	Dolomite	Limestone	Dolomite
1	6	4	5	9
2	8	6	5	4
3	6	10	6	8
Avg	7	7	5	7

Freezing and Thawing in Water and Alcohol (CRD-C 144):

Type of Stone	Specimen No.	Original OD wt. g	Final OD wt. of Fragments Larger Than 25 % of Original wt. g	%	Wt Loss During Test, %	Cycles Completed
Limestone	1	5710	0	0.0	100	14
	2	5567	5552	99.7	0.3	20
	3	5233	4917	94.0	6.0	20
	Avg				35.4	
Dolomite	1	5403	3728	69.0	31.0	20
	2	5598	5465	97.6	2.4	20
	3	3229	3048	94.4	5.6	20
	Avg				12.7	

WES Form No. 1115
Rev. March 1964

Riprap Data Sheet

1. Samples were taken from the intervals shown below for riprap tests:

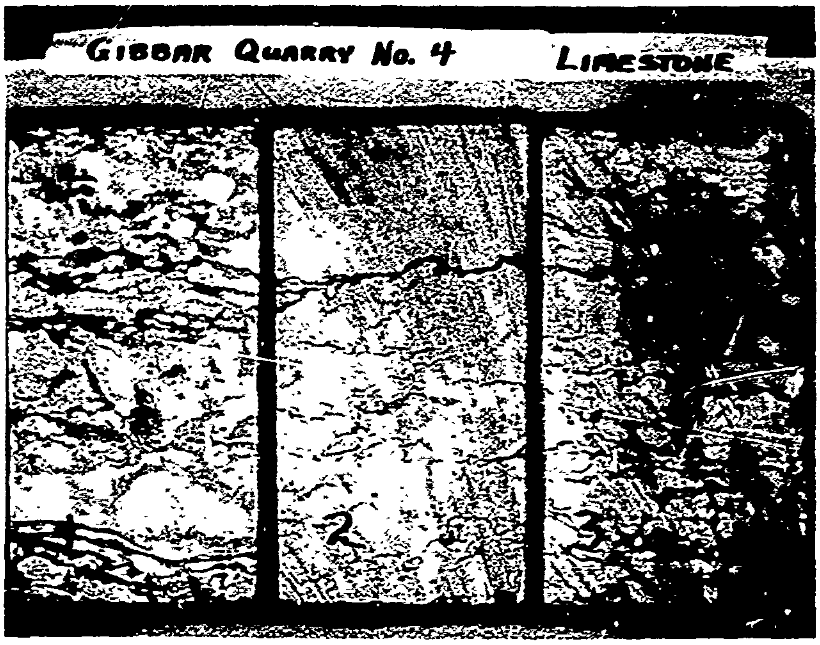
Depths, ft	Rock Type
39.4 to 40.3	Dolomite
54.5 to 55.6	
59.6 to 60.6	
68.1 to 69.0	
79.4 to 80.3	
82.4 to 83.5	Limestone
86.4 to 87.3	
95.7 to 96.8	
104.6 to 105.7	
117.0 to 118.0	

2. After 20 cycles of freezing and thawing according to CRD-C 144, the following observations were made:

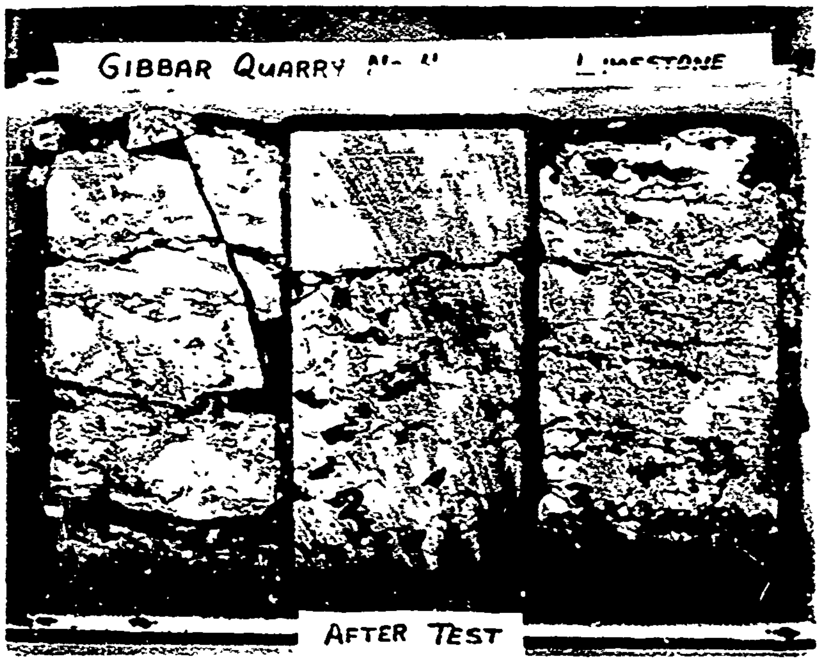
a. Limestone: Piece 1 had fragmented into pieces weighing less than 25 percent of the original weight. Piece 2 had lost minor amounts of material; Piece 3 slightly more; both were fragile.

Dolomite: The chert band in Piece 1 was disrupted; its weight c[illegible]ned with the weight of the otherwise unaffected end of the slab was 31 percent of the original. Losses from the other two pieces were trivial.

3

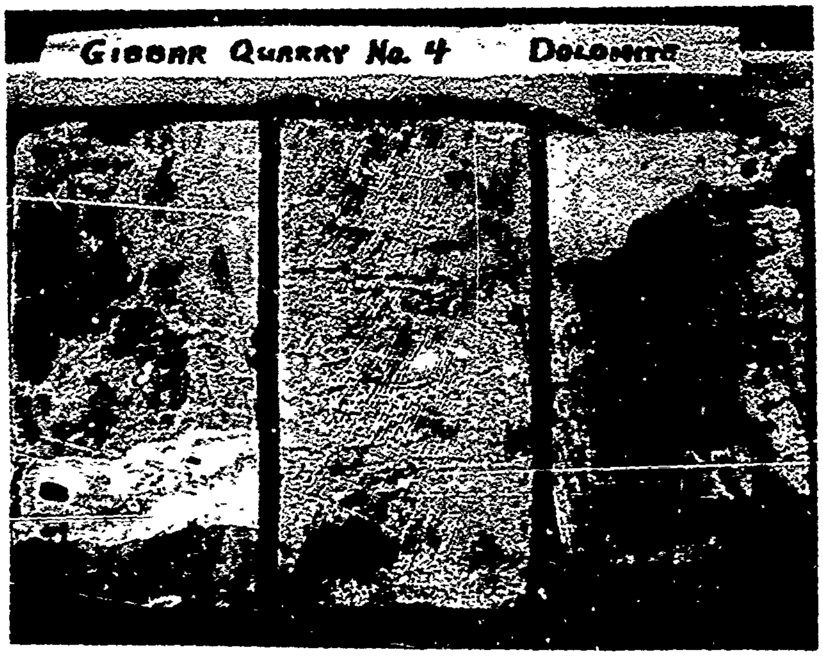


a. Before test

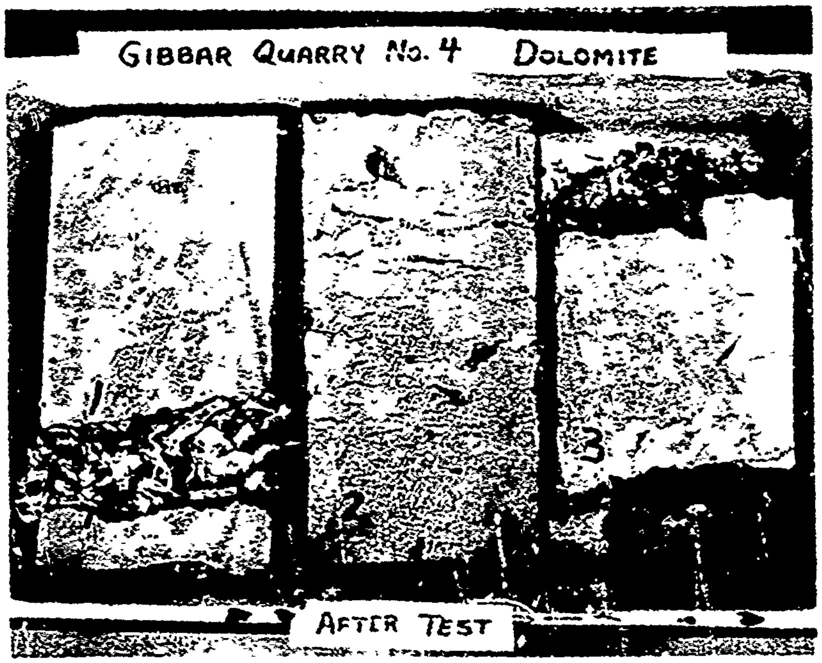


b. After test

Fig. 1A. Gibbar Quarry stone tested for freezing and thawing in an 0.5 percent solution of water and alcohol.



a. Before test



b. After test

Fig. 1B. Gibbar Quarry stone tested for freezing and thawing in an 0.5 percent solution of water and alcohol.

STATE Missouri	INDEX NO:	RIPRAP DATA SHEET	[illegible]
LAT. 38	LONG. 90		DATE: [illegible]

LAB. SYMBOL NO.: STL-19 G-2 TYPE OF MATERIAL: Limestone [illegible]

LOCATION: Sec 19. R 9 E, T 38 N, Ste. Genevieve County, Missouri, at [illegible] Rock, Missouri.

PRODUCER: West Lake Quarry and Materials Co., Box 206, [illegible], [illegible] Missouri.

SAMPLED BY: St. Louis District

TESTED FOR: Kaskaskia River, Illinois, Navigation Improvement

PROCESSING BEFORE TESTING:

GEOLOGICAL FORMATION AND AGE: Ste. Genevieve limestone and St. Louis limestone, Meramec group, Middle Mississippian Age.

GRADING (CRD-C 103)(CUM. % PASSING)

SIEVE	3-6"	1½-3"	¾-1½"	#4-¾"	FINE AGG.
6 IN.					
5 IN.					
4 IN.					
3 IN.					
2½ IN.					
2 IN.					
1½ IN.					
1 IN.					
¾ IN.					
½ IN.					
⅜ IN.					
NO. 4					
NO. 8					
NO 16					
NO 30					
NO 50					
NO 100					
NO. 200					
-200(a)					
F.M.(b)					

(a) CRD-C 105 (b) CRD-C 104

TEST RESULTS

	Limestone Den-se	Sha-ly	[illegible]	Oo-litic	FINE AGG.
BULK SP. GR, SAT SURF DRY (CRD-C 107,108):	2.66	2.67	2.52	2.65	
ABSORPTION, PER CENT (CRD-C 107, 108).	0.3	0.2	2.2	0.2	
ORGANIC IMPURITIES, FIG. NO (CRD-C 121):	—	—	—	—	
SOFT PARTICLES, PER CENT (CRD-C 130):					—
PER CENT LIGHTER THAN SP. GR. ____ (CRD-C 129):					—
PER CENT FLAT AND ELONGATED (CRD-C 119, 120):					
WEIGHTED AV. % LOSS, 5 CYC $MgSO_4$ ((c) ½-1", #4-½) (CRD-C 115)					
ABRASION LOSS (L. A), %, (CRD-C 117):	[illegible]	[illegible]	[illegible]	[illegible]	—
UNIT WT., LB/CU FT (CRD-C 107):	[illegible]	[illegible]	[illegible]	165.[illegible]	
Toughness (CRD-C 132):	7/4*	[illegible]	[illegible]	9/[illegible]	
COAL AND LIGNITE, % (CRD-C 122):	—	—	—	—	
SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):					
REACTIVITY WITH NaOH (CRD-C 128) Sc, mM/L					
Rc, mM/L					

MORTAR-MAKING PROPERTIES (CRD-C 116)

TYPE ______ CEMENT, RATIO ______ DAYS, ______ %, ______ DAYS, ______ %

LINEAR THERMAL EXPANSION X10⁻⁶/DEG. F. (CRD-C 125,126)

ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE

MORTAR:

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123)	FINE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.	COARSE AGGREGATE 3 MO.	6 MO	9 MO	12 MO
LOW-ALK. CEMENT: % Na_2O EQUIVALENT:								
HIGH-ALK. CEMENT: % Na_2O EQUIVALENT:								

SOUNDNESS IN CONCRETE (CRD-C 40, 114):

			F & T	HW-CD	HD-CW
FINE AGG.	COARSE AGG:	DFE 100			
FINE AGG.	COARSE AGG:	DFE 300			

PETROGRAPHIC DATA (CRD-C 127):

REMARKS: * The number to the left is the height of the blow at failure in cm, perpendicular to the structural weakness and the number to the right is the height of the blow parallel to the structural weakness of the sample.

WES FORM 726 JAN. 1951

Corps of Engineers, USAE	Riprap Data Sheet	Concrete Division P. O. Drawer 2131 Jackson, Mississippi

Project
Kaskaskia River, Illinois, Navigation Improvement

Date
May 1965

STL-19 G-2 (6-in. Core) West Lake Quarry No. 5

Toughness (CRD-C 132):

Test No.	Height of Blow at Failure, cm							
	Perpendicular to Plane of Structural Weakness				Parallel to Plane of Structural Weakness			
	Dense	Shaly	Soft Weathered	Oolitic	Dense	Shaly	Soft Weathered	Oolitic
1	7	8	5	7	4	7	3	8
2	8	12	5	6	4	8	4	7
3	7	11	5	9	3	9	5	6
Avg	7	10	5	7	4	8	4	7

Freezing and Thawing in Water and Alcohol (CRD-C 144):

Type of Stone	Specimen No.	Original OD wt. g	Final OD wt. of Fragments Larger Than 25 % of Original wt. g	%	Wt Loss During Test, %	Cycles Completed
Dense Limestone	1	5133	5113	99.6	0.4	20
	2	5035	4745	94.2	5.8	20
	3	4443	3806	85.7	14.3	14
	Avg				6.8	
Shaly Limestone	1	5122	5081	99.2	0.8	20
	2	5422	4201	77.5	22.5	17
	3	5124	4935	96.3	3.7	20
	Avg				9.0	
Soft Weathered Limestone	1	4576	4465	97.6	2.4	20
	2	4265	4238	99.4	0.6	20
	3	4504	4267	94.7	5.3	20
	Avg				2.8	
Oolitic	1	4430	4419	99.7	0.3	20
	2	5325	5315	99.8	0.2	20
	3	4563	4553	99.8	0.2	20
	Avg				0.2	

WES Form No. 1115
Rev. March 1964

Riprap Data Sheet

1. Samples were taken from the intervals and holes shown below for riprap tests:

Oolitic Limestone Depth, ft	Hole
11.5 to 12.2	WSG-1
12.2 to 13.1	WSG-1
17.7 to 18.7	WSG-1
20.6 to 21.3	WSG-1
30.3 to 31.0	WSG-1

Shaly Limestone Depth, ft	Hole
42.3 to 43.3	WSG-1A
45.7 to 46.3	WSG-1A
48.3 to 49.3	WSG-1A
75.4 to 76.2	WSG-1A
79.1 to 80.2	WSG-1A

Soft Weathered Limestone Depth, ft	Hole
84.1 to 84.8	WSG-1A
89.2 to 89.7	WSG-1A
89.7 to 90.4	WSG-1A
90.4 to 91.1	WSG-1A

Dense Limestone Depth, ft	Hole
6.5 to 8.0	WSG-1B
8.4 to 9.2	WSG-1A
23.0 to 24.2	WSG-1A
32.8 to 34.0	WSG-1
64.0 to 65.0	WSG-1A

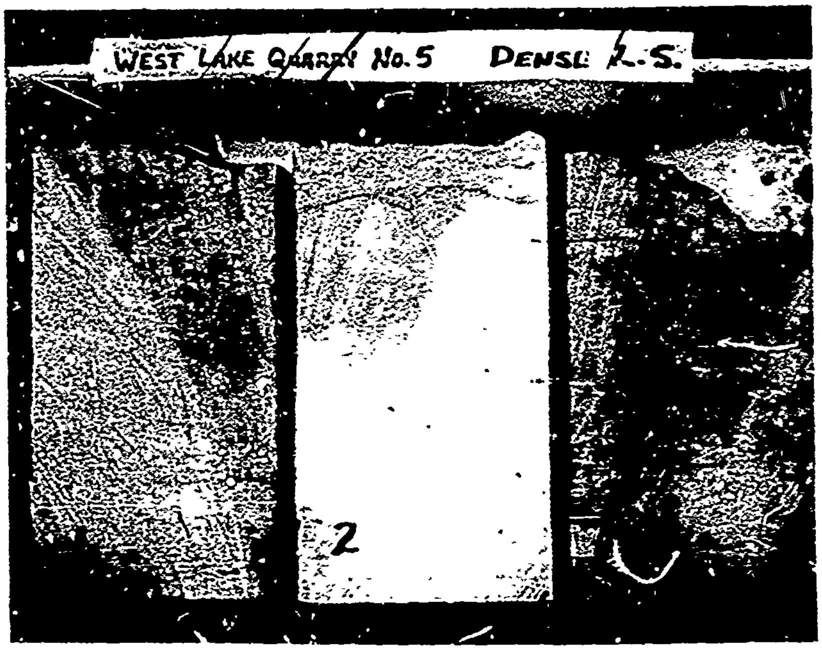
2. After 20 cycles of freezing and thawing according to CRD-C 144 the following observations were made:

a. Dense limestone: Pieces 1 and 2 pratically unaffected. Piece 3 broke into three fragments along an old crack.

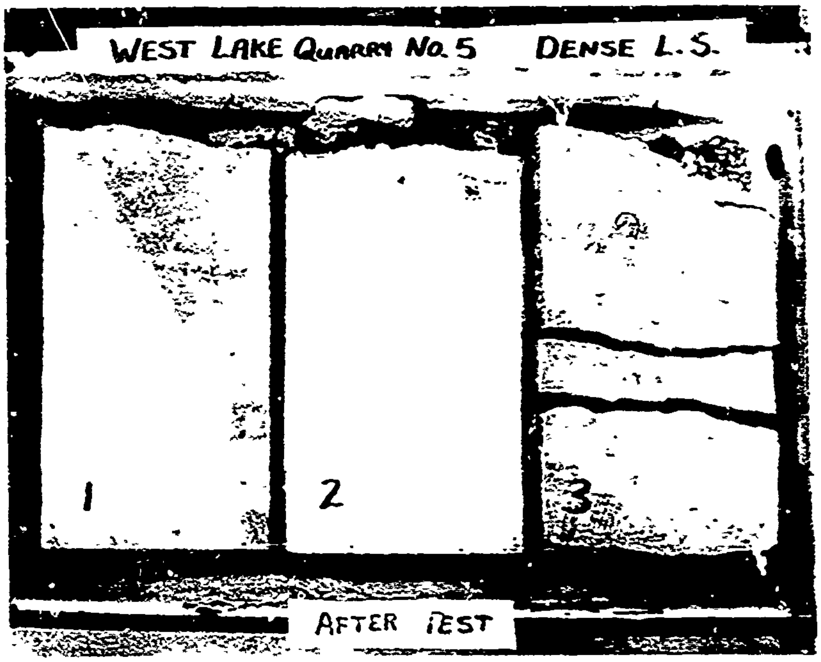
b. Shaly limestone: No effect on Piece 1. Pieces 2 and 3 broke into two and three fragments; rock still strong.

c. Soft weathered limestone: No effect on Pieces 1 and 2. Some surface spalling around old cracks in Piece 3. Rock still strong.

d. Oolitic limestone: The test had practically no effect on the three pieces of rock.

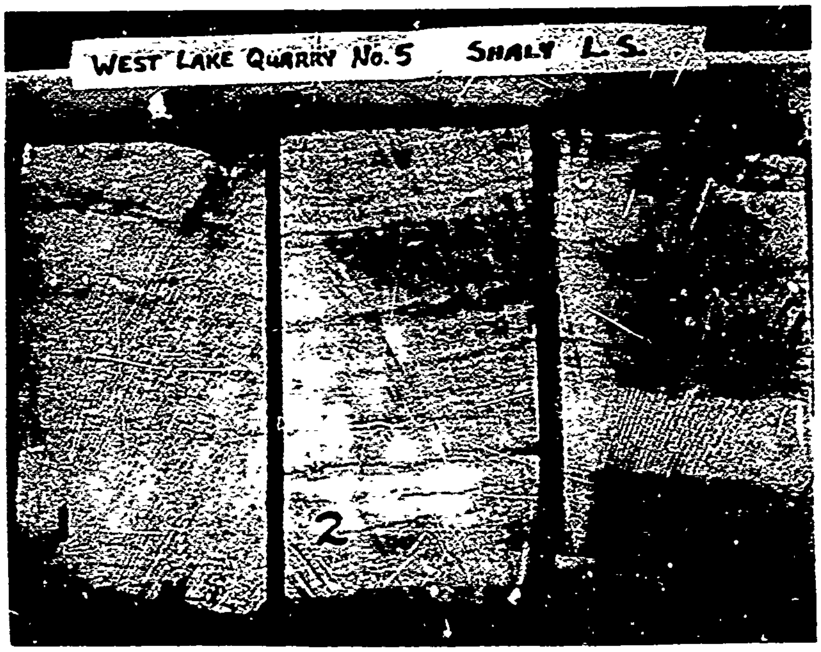


a. Before test

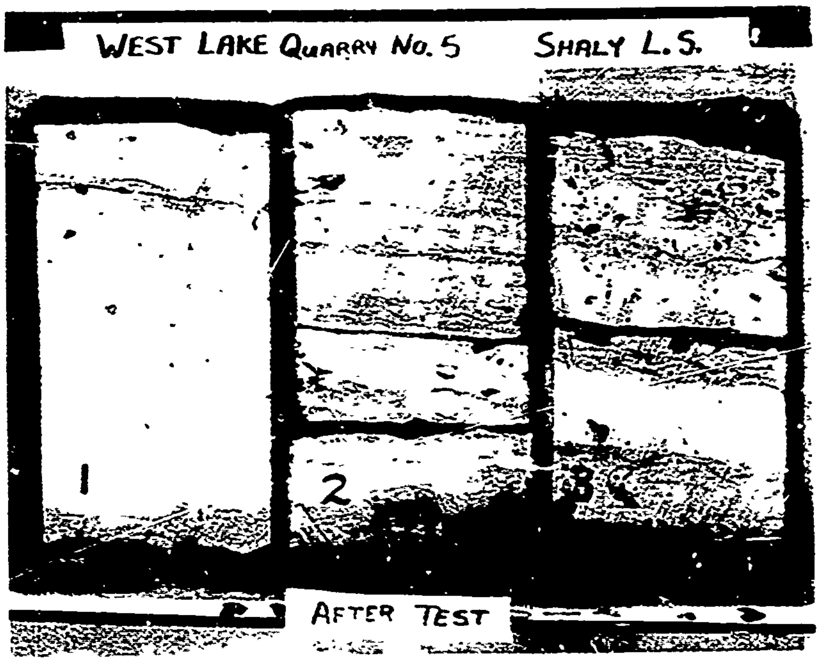


b. After test

Fig. 2A. West Lake Quarry No. 5 stone tested for freezing and thawing in an 0.5 percent solution of water and alcohol.



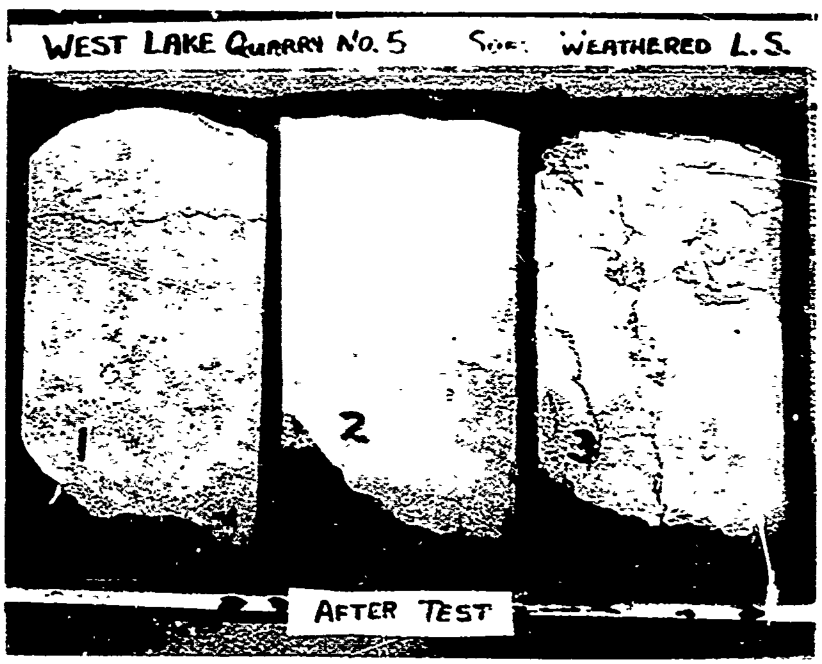
a. Before test



b. After test

Fig. 2B. West Lake Quarry No. 5 stone tested for freezing and thawing in an 0.5 percent solution of water and alcohol.

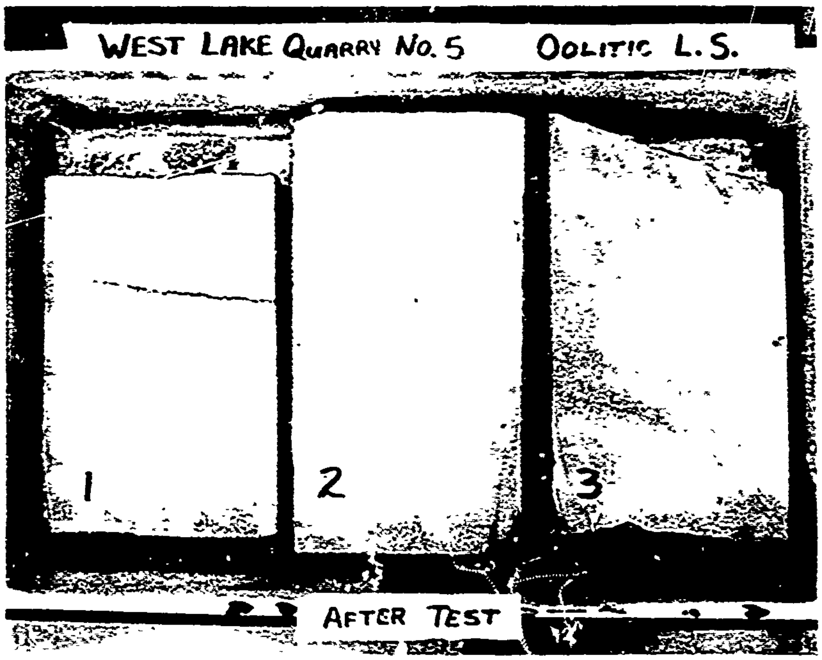
a. Before test



b. After test

Fig. 2C. West Lake Quarry No. 5 stone tested for freezing and thawing in an 0.5 percent solution of water and alcohol.

a. Before test



b. After test

Fig. 2D. West Lake Quarry No. 5 stone tested for freezing and thawing in an 0.5 percent solution of water and alcohol.

STATE: Illinois	INDEX NO:	RIPRAP DATA SHEET	TESTED BY: USAEWES
LAT.: 38	LONG.: 90		DATE: May 1965

LAB. SYMBOL NO.: STL-19 G-3(A) and G-3(B) TYPE OF MATERIAL: Ledge rock

LOCATION: Sec 16, R 9 W, T 5 S, Randolph County, Illinois, 1/2-mile N of Prairie du Rocher, Illinois

PRODUCER: Stotz Quarry, Prairie du Rocher, Illinois

SAMPLED BY: St. Louis District

TESTED FOR: Kaskaskia River, Illinois, Navigation Improvement

PROCESSING BEFORE TESTING:

GEOLOGICAL FORMATION AND AGE:

GRADING (CRD-C 103)(CUM. % PASSING):

SIEVE	3-6"	1½-3"	¾-1½"	#4-¾"	FINE AGG.
6 IN.					
5 IN.					
4 IN.					
3 IN.					
2½ IN.					
2 IN.					
1½ IN.					
1 IN.					
¾ IN.					
½ IN.					
⅜ IN.					
NO. 4					
NO. 8					
NO. 16					
NO. 30					
NO. 50					
NO. 100					
NO. 200					
-200[a]					
F.M.[b]					

(a) CRD-C 105 (b) CRD-C ...

TEST RESULTS

	3-6"	G-3A Dense Limestone	G-3A Shaly Limestone	G-3B Dense Limestone	FINE AGG.
BULK SP. GR., SAT SURF DRY (CRD-C 107,108):		2.67	2.66	2.68	
ABSORPTION, PER CENT (CRD-C 107,108):		0.4	0.6	0.[illegible]	
ORGANIC IMPURITIES, FIG. NO (CRD-C 121):	—	—	—	—	
SOFT PARTICLES, PER CENT (CRD-C 130):					—
PER CENT LIGHTER THAN SP.GR.____(CRD-C 129):					—
PER CENT FLAT AND ELONGATED (CRD-C 119,120):					
WEIGHTED AV. % LOSS, 5 CYC. $MgSO_4$ ((c) ½-1", #4-½)(CRD-C 115)					
ABRASION LOSS (L. A.), %, (CRD-C 117):		32.8	25.8	29.8	—
UNIT WT., LB/CU FT (CRD-C 107):		166.3	165.7	167.0	
Toughness (CRD-C 132):		7/7*	7/8*	8/7*	
COAL AND LIGNITE, % (CRD-C 122):	—	—	—	—	
SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):					
REACTIVITY WITH NaOH (CRD-C 128): Sc, mM/L:					
Rc, mM/L:					

MORTAR-MAKING PROPERTIES (CRD-C 116)

TYPE____CEMENT, RATIO____DAYS,____%,____DAYS,____%

LINEAR THERMAL EXPANSION X10⁻⁶/DEG. F. (CRD-C 125,126)

ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE

MORTAR:

MORTAR-BAR EXPANSION, %, (CRD-C 123):	FINE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.	COARSE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK. CEMENT: % Na_2O EQUIVALENT:								
HIGH-ALK. CEMENT: % Na_2O EQUIVALENT:								

SOUNDNESS IN CONCRETE (CRD-C 40, 114):			F & T	HW-CD	HD-CW
FINE AGG.	COARSE AGG:	DFE_{300}			
FINE AGG.	COARSE AGG:	DFE_{300}			

PETROGRAPHIC DATA (CRD-C 127):

REMARKS: *The number to the left is the height of the blow at failure in cm, perpendicular to the structural weakness and the number to the right is the height of the blow parallel to the structural weakness of the sample.

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Corps of Engineers, USAE	Riprap Data Sheet	Concrete Division P. O. Drawer 2131 Jackson, Mississippi

Project: Kaskaskia River, Illinois, Navigation Improvement — Date: May 1965

STL-19 G-3(A) Upper 13-ft and middle 10-ft ledges, Stotz Quarry

Toughness (CRD-C 132):

Test No.	Height of Blow at Failure, cm			
	Perpendicular to Plane of Structural Weakness		Parallel to Plane of Structural Weakness	
	Dense Limestone	Shaly Limestone	Dense Limestone	Shaly Limestone
1	5	7	6	6
2	8	8	9	10
3	6	7	6	7
Avg	7	7	7	8

Freezing and Thawing in Water and Alcohol (CRD-C 144):

Type of Stone	Specimen No.	Original OD wt. g	Final OD wt. of Fragments Larger Than 25 % of Original wt. g	%	Wt Loss During Test, %	Cycles Completed
Dense Limestone	1	4006	3969	99.1	0.9	20
	2	4520	4509	99.7	0.3	20
	3	4584	4521	98.6	1.4	20
	Avg				0.9	
Shaly Limestone	1	4274	3658	85.6	14.4	20
	2	4232	4178	98.7	1.3	20
	3	4425	4400	99.4	0.6	20
	Avg				7.8	

WES Form No. 1115
Rev. March 1964

Corps of Engineers, USAE	Riprap Data Sheet	Concrete Division P. O. Drawer 2131 Jackson, Mississippi

Project
Kaskaskia River, Illinois, Navigation Improvement

Date
May 1965

STL-19 G-3(B) Lower 14-ft Ledge, Stotz Quarry

Toughness (CRD-C 132):

Test No.	Height of Blow at Failure, cm Perpendicular to Plane of Structural Weakness	Height of Blow at Failure, cm Parallel to Plane of Structural Weakness
1	6	8
2	9	7
3	9	6
Avg	8	7

Freezing and Thawing in Water and Alcohol (CRD-C 144):

Type of Stone	Specimen No.	Original OD wt. g	Final OD wt. of Fragments Larger Than 25 % of Original wt. g	Final OD wt. of Fragments Larger Than 25 % of Original wt. %	Wt Loss During Test, %	Cycles Completed
Dense	1	4301	42[illegible]	99.6	0.4	20
Limestone	2	5248	5228	99.6	0.4	20
	3	4487	4463	99.5	0.5	20
	Avg				0.4	

WES Form No. 1115
Rev. March 1964

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Riprap Data Sheet

1. After 20 cycles of freezing and thawing according to CRD-C 144 the following observations were made:

a. STL-19 G-3(A).

(1) Dense limestone: Very light surface spalling and and fragmentation along stylolites of all 3 pieces. Piece 3 developed open crack and was becoming fragile.

(2) Shaly limestone: This rock was much like the dense rock once it was sawed. Light surface spalling and fragmentation along cracks and stylolites during test. Piece 1 lost two large fragments along old cracks. Pieces 2 and 3 were becoming fragile.

b. STL-19 G-3(B).

(1) Dense limestone: Light surface spalling and fragmentation along stylolites. Piece 3 developed a crack.

c. Both ledges. Visible effects of test more pronounced in rock from upper ledge (3A). Some tendency for rock to develop cracks perpendicular to bedding direction, thus becoming fragile.

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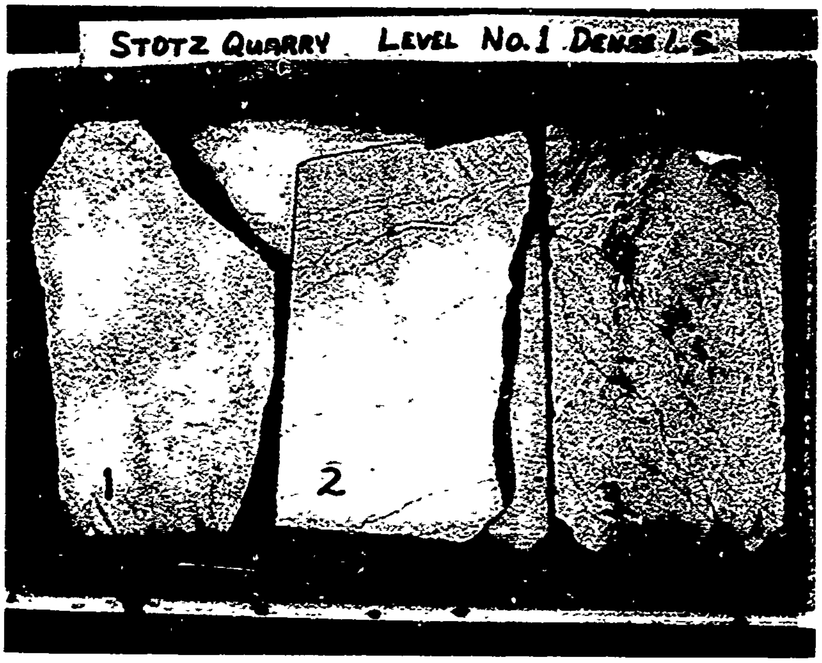
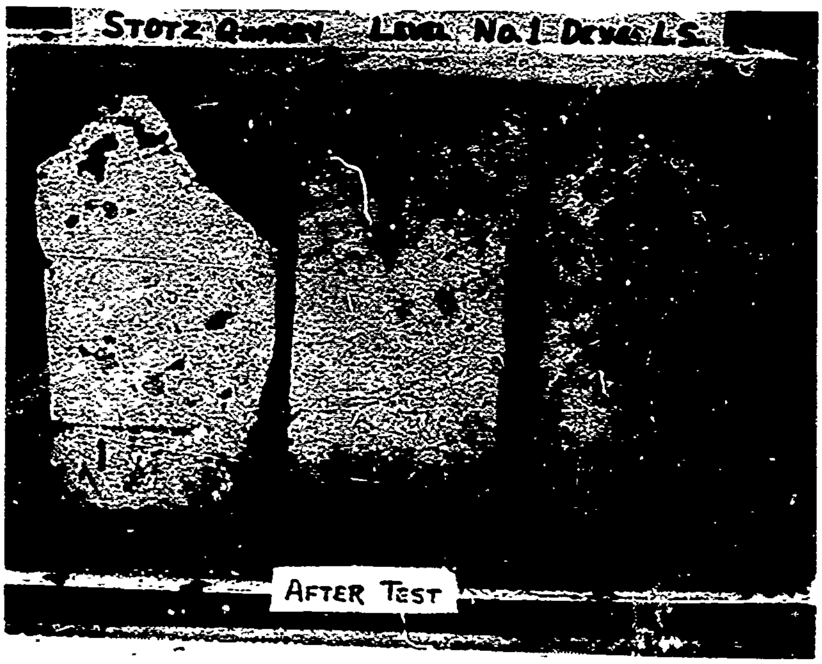
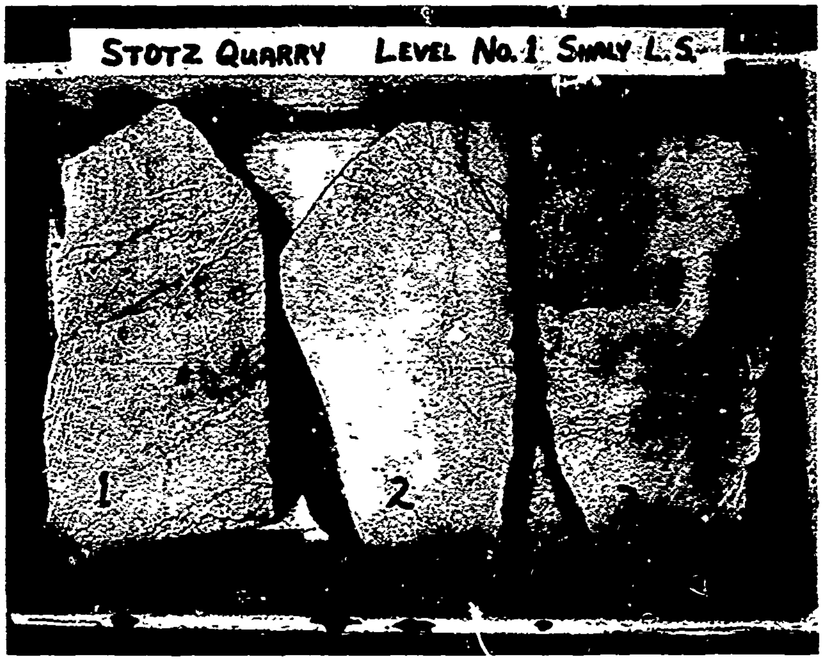


a. Before test

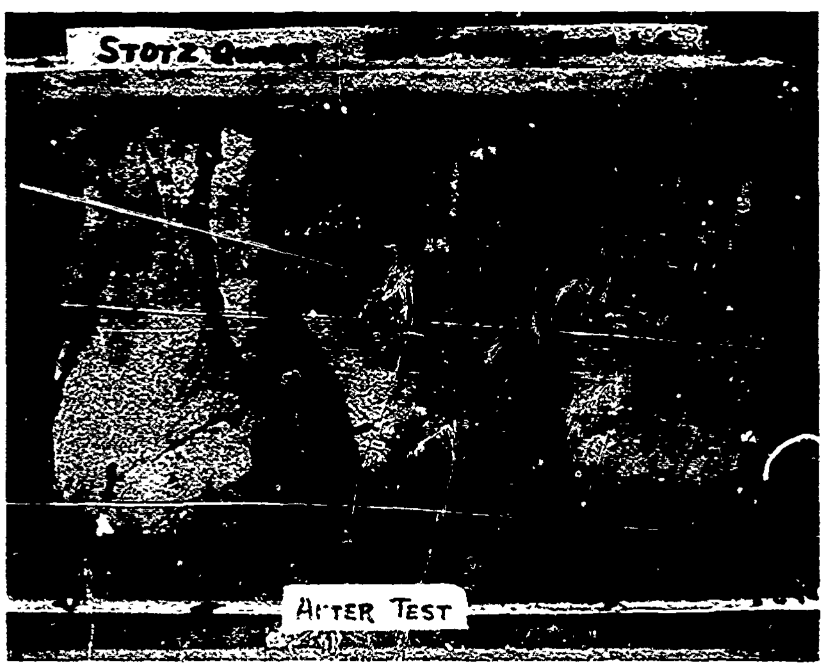


b. After test

Fig. 3A. Stotz Quarry stone from ledges 1 and 2 tested for freezing and thawing in an 0.5 percent solution of water and alcohol.

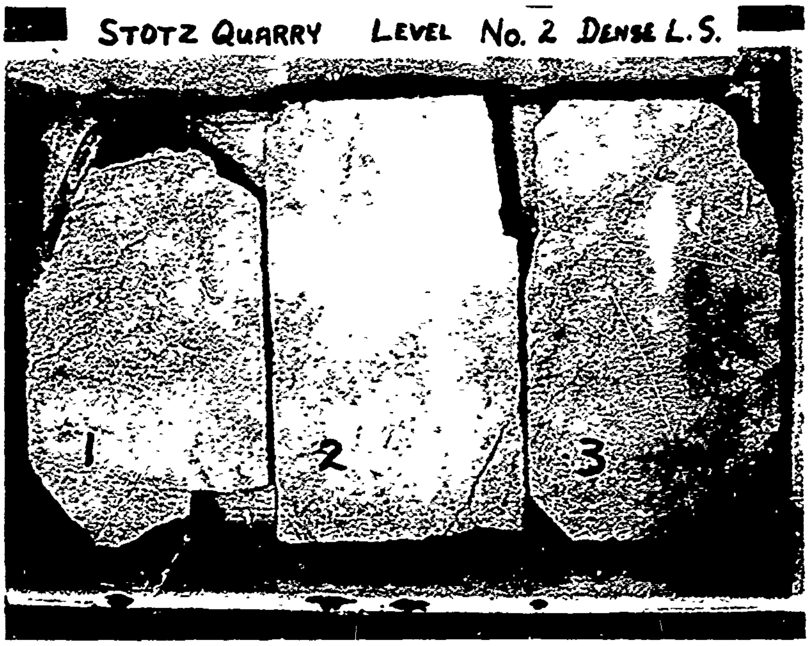


a. Before test

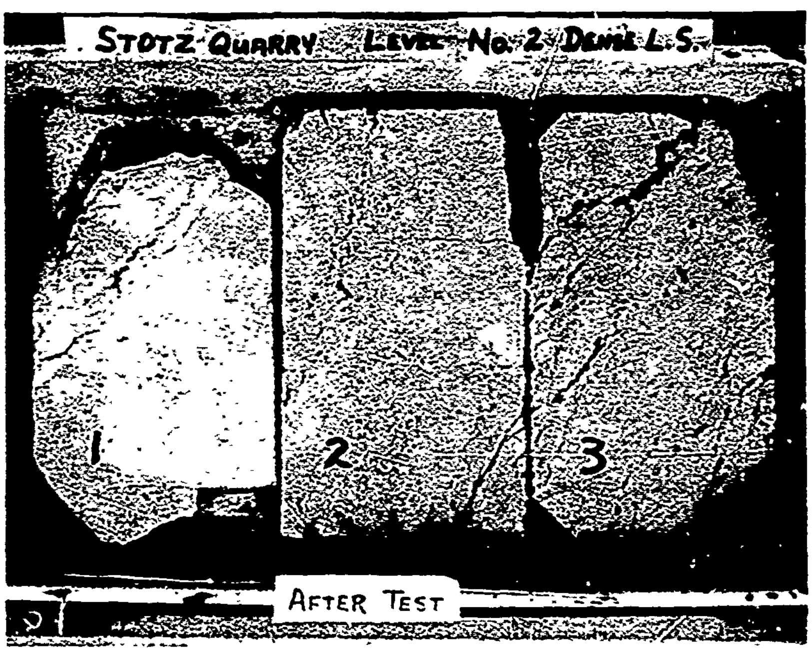


b. After test

Fig. 3B. Stotz Quarry stone from ledges 1 and 2 tested for freezing and thawing in an 0.5 percent solution of water and alcohol.



a. Before test



b. After test

Fig. 3C. Stotz Quarry stone from ledge 3 tested for freezing and thawing in an 0.5 percent solution of water and alcohol.

STATE: Missouri | INDEX NO | **RIPRAP DATA SHEET** | TESTED BY: USAED, S

LAT.: 38 | LONG.: 90 | DATE: May 1965

LAB. SYMBOL NO.: STL-19 G-4(A), 4(B), 4(C), 4(D) TYPE OF MATERIAL: Ledge rock

LOCATION: Sec 12, R 8 E, T 38 N, Ste. Genevieve County, Missouri

PRODUCER: Charlie Bussen Quarry, Ste. Genevieve, Missouri

SAMPLED BY: St. Louis District

TESTED FOR: Kaskaskia River, Illinois, Navigation Improvement

PROCESSING BEFORE TESTING

GEOLOGICAL FORMATION AND AGE: Salem Limestone, Meramec group, Middle Mississippian Age

GRADING (CRD-C 103)(CUM. % PASSING):

SIEVE	3-6"	1½-3"	¾-1½"	#4-¾"	FINE AGG.
6 IN.					
5 IN.					
4 IN.					
3 IN.					
2½ IN.					
2 IN.					
1½ IN.					
1 IN.					
¾ IN.					
½ IN.					
⅜ IN.					
NO 4					
NO. 8					
NO. 16					
NO 30					
NO. 50					
NO. 100					
NO. 200					
-200[a]					
F.M.[b]					

(a) CRD-C 105 (b) CRD-C 104

TEST RESULTS

	G-3A Ledge 1	G-3B Ledge 2	G-3C Ledge 3 LS	G-3C Ledge 3 LS	G-3D Ledge 4
BULK SP. GR, SAT SURF DRY (CRD-C 107,108):	2.61	2.64	2.61	2.61	2.62
ABSORPTION, PER CENT (CRD-C 107,108):	1.6	0.7	1.5	1.1	0.7
ORGANIC IMPURITIES, FIG. NO (CRD-C 121):	—	—	—	—	
SOFT PARTICLES, PER CENT (CRD-C 130):					—
PER CENT LIGHTER THAN SP.GR.____ (CRD-C 129):					—
PER CENT FLAT AND ELONGATED (CRD-C 119,120):					
WEIGHTED AV. % LOSS, 5 CYC. $MgSO_4$ ((C) ½-1", #4-½) (CRD-C 115)					
ABRASION LOSS (L. A.), %, (CRD-C 117):	26.6	24.7	28.5	28.4	22.9
UNIT WT., LB/CU FT (CRD-C 107):	152.6	164.5	162.6	162.4	163.2
Toughness (CRD-C 132):	7/9*	9/8*	7/7*	9/8*	7/8*
COAL AND LIGNITE, % (CRD-C 122):	—	—	—	—	
SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):					
REACTIVITY WITH NaOH (CRD-C 128): Sc, mM/L					
Rc, mM/L					

MORTAR-MAKING PROPERTIES (CRD-C 116)

TYPE______CEMENT, RATIO______DAYS,________%,________DAYS,________%

LINEAR THERMAL EXPANSION X10 ⁶/DEG. F. (CRD-C 125,126):

ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE

MORTAR:

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):

	Fine Aggregate 3 MO.	6 MO.	9 MO.	12 MO.	Coarse Aggregate 3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK. CEMENT: % Na_2O EQUIVALENT:								
HIGH-ALK. CEMENT: % Na_2O EQUIVALENT:								

SOUNDNESS IN CONCRETE (CRD-C 40, 114):

			F & T	HW-CD	HD-CW
FINE AGG.	COARSE AGG:	DFE_{300}			
FINE AGG.	COARSE AGG:	DFE_{300}			

PETROGRAPHIC DATA (CRD-C 127):

REMARKS: * The number to the left is the height of the blow at failure in cm, perpendicular to the structural weakness and the number to the right is the height of the blow parallel to the structural weakness of the samples.

1b

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Corps of Engineers, USAE	Riprap Data Sheet	Concrete Division P. O. Drawer 2131 Jackson, Mississippi

Project
Kaskaskia River, Illinois, Navigation Improvement

Date
May 1965

STL-19 G-4(A) Ledge No. 1, Bussen Quarry

Toughness (CRD-C 132):

Test No.	Height of Blow at Failure, cm: Perpendicular to Plane of Structural Weakness	Height of Blow at Failure, cm: Parallel to Plane of Structural Weakness
1	6	8
2	8	10
3	8	9
Avg	7	9

Freezing and Thawing in Water and Alcohol (CRD-C 144):

Type of Stone	Specimen No.	Original OD wt. g	Final OD wt. of Fragments Larger Than 25 % of Original wt. g	%	Wt Loss During Test, %	Cycles Completed
Dense	1	3272	3261	99.7	0.3	20
Limestone	2	4088	4052	99.1	0.9	20
	3	5313	5308	99.9	0.1	20
	Avg				0.4	

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Rev. March 1964

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Corps of Engineers, USAE	Riprap Data Sheet	Concrete Division ... Jackson, Mississippi

Project
Kaskaskia River, Illinois, Navigation Improvement — May 1965

STL-19 G-4(B) Ledge No. 2, Bussen Quarry

Toughness (CRD-C 132):

Test No.	Height of Blow at Failure, cm: Perpendicular to Plane of Structural Weakness	Height of Blow at Failure, cm: Parallel to Plane of Structural Weakness
1	9	9
2	8	11
3	9	7
Avg	9	9

Freezing and Thawing in Water and Alcohol (CRD-C 144):

Type of Stone	Specimen No.	Original OD wt. g	Final OD wt. of Fragments Larger Than 25 % of Original wt. g	Final OD wt. of Fragments Larger Than 25 % of Original wt. %	Wt Loss During Test, %	Cycles Completed
Dense	1	4467	4453	99.7	0.3	20
Limestone	2	4687	4677	99.8	0.2	20
	3	4482	4475	99.8	0.2	20
	Avg				0.2	

Corps of Engineers, USAE	Riprap Data Sheet	Concrete Division

Project: Kaskaskia River, Illinois, Navigation Improvement — Date: May 1965

STL-19 G-4 (C) Ledge No. 3, Buser Quarry

Toughness (CRD-C 132):

Test No.	Height of Blow at Failure, cm: Perpendicular to Plane of Structural Weakness — Shaly Limestone	Perpendicular — Dense Limestone	Parallel to Plane of Structural Weakness — Shaly Limestone	Parallel — Dense Limestone
1	7	8	7	8
2	7	10	8	7
3	7	10	6	8
Avg	7	9	7	8

Freezing and Thawing in Water and Alcohol (CRD-C 14):

Type of Stone	Specimen No.	Original OD wt. g	Final OD wt. of Fragments Larger Than 25 % of Original wt. g	%	Wt Loss During Test, %	Cycles Completed
Shaly Limestone	1	4897	4785	97.7	2.3	20
	2	4853	4810	99.1	0.9	20
	3	4319	4269	98.8	1.2	20
	Avg				1.5	
Dense Limestone	1	4766	4729	99.2	0.8	20
	2	4492	4484	99.8	0.2	20
	3	4022	3971	98.7	1.3	20
	Avg				0.8	

WES Form No. 1115
Rev. March 1964

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Corps of Engineers, USAE	Riprap Data Sheet	Concrete Division J. M. … Jackson, Mississippi

Project
Kaskaskia River, Illinois, Navigation Improvement

Date
May 1965

STL-19 G-4(D), Ledge No. 4, Bussen Quarry

Toughness (CRD-C 132):

	Height of Blow at Failure, cm	
Test No.	Perpendicular to Plane of Structural Weakness	Parallel to Plane of Structural Weakness
1	8	7
2	6	10
3	6	8
Avg	7	8

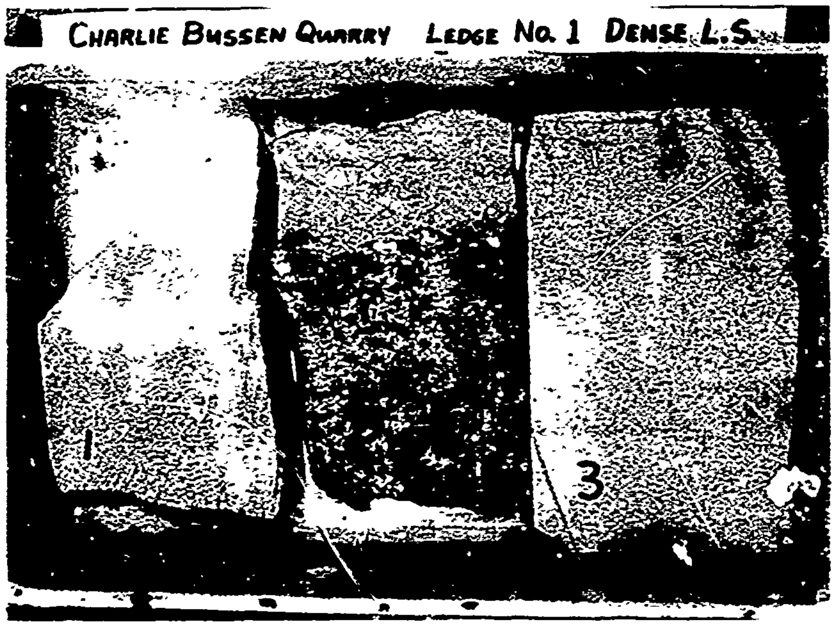
Freezing and Thawing in Water and Alcohol (CRD-C 144):

Type of Stone	Specimen No.	Original OD wt. g	Final OD wt. of Fragments Larger Than 25 % of Original wt. g	Final OD wt. of Fragments Larger Than 25 % of Original wt. %	Wt Loss During Test, %	Cycles Completed
Dense Limestone	1	4932	4925	99.9	0.1	20
	2	4722	4719	99.9	0.1	20
	3	4319	4300	99.6	0.4	20
	Avg				0.2	

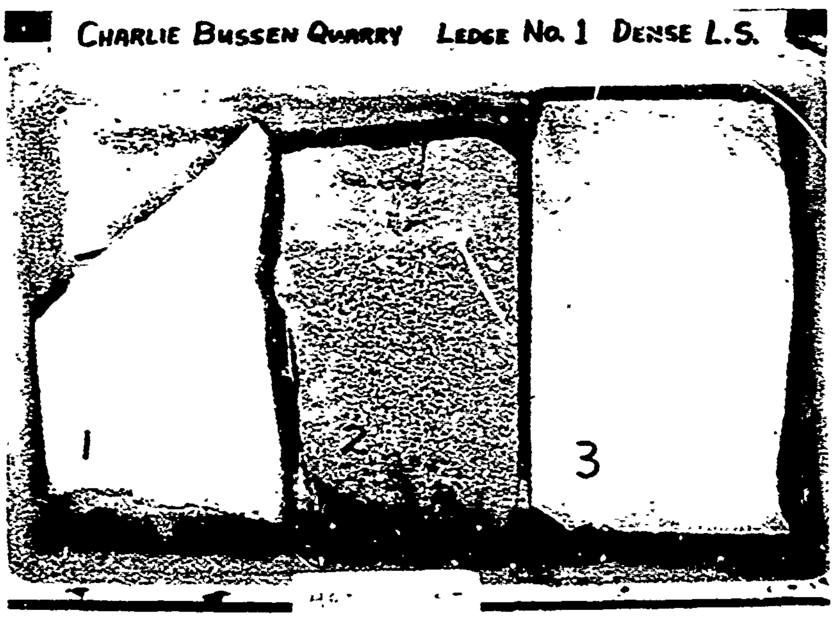
WES Form No. 1115
Rev. March 1964

Riprap Data Sheet

After 20 cycles of freezing and thawing the following observations were made of samples STL-19 G-4(A) through G-4(D). There was little effect on any of the rock tested except the shaly pieces of ledge 4C. Two of the shaly pieces showed spalling and cracking along bedding planes. The rock of the slabs from ledges 4A through 4D was like the rock from the Stotz Quarry (STL-19 G-3(A), G-3(B)), in appearance, but there were less effects of the test visible on the Dussen rock slabs.

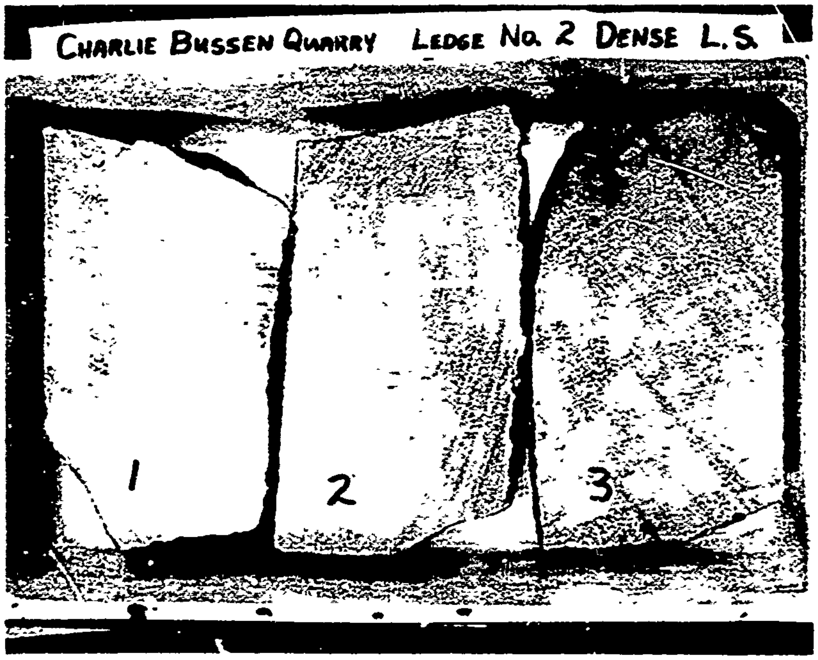


a. Before test

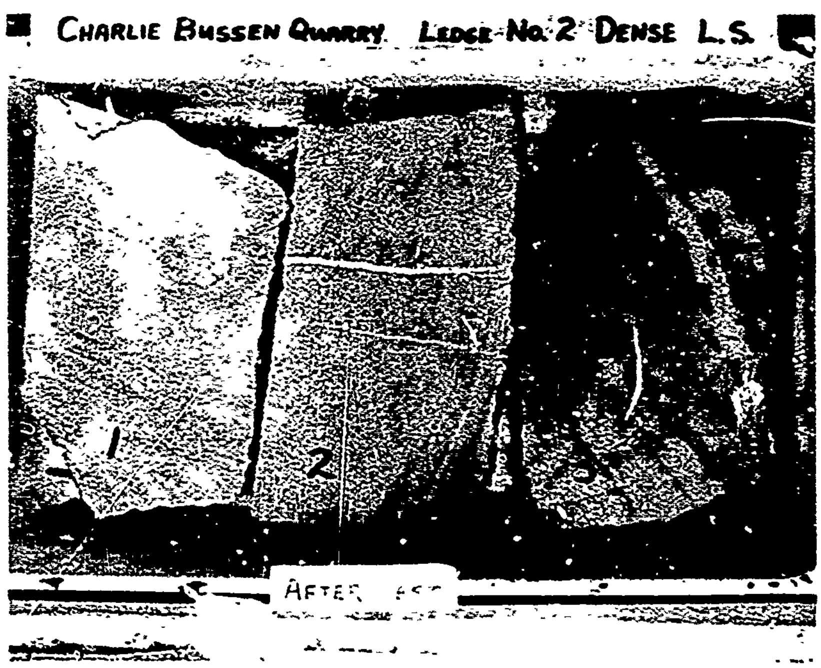


b. After test

Fig. 4A. Bussen Quarry stone from ledge No. 1 tested for freezing and thawing in an 0.5 percent solution of water and alcohol.

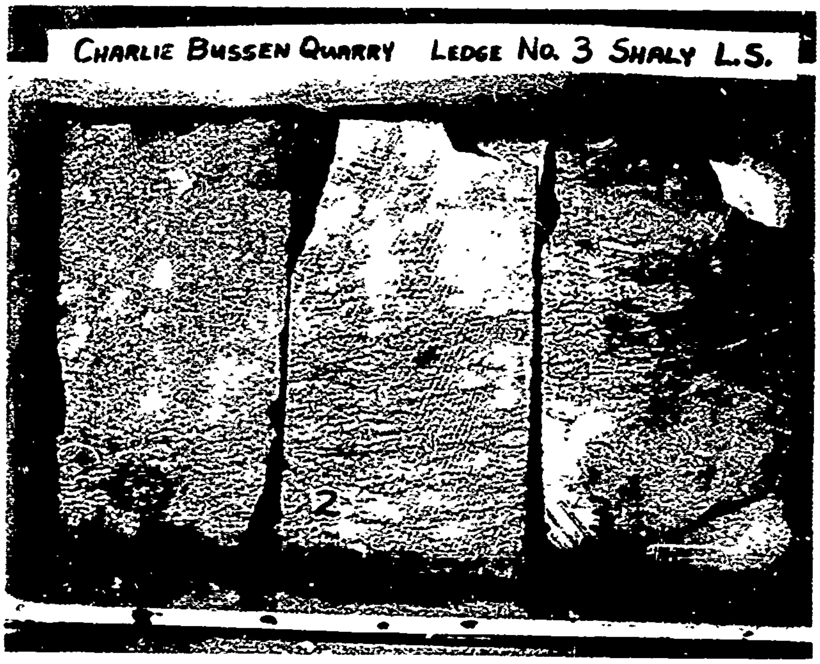


a. Before Test

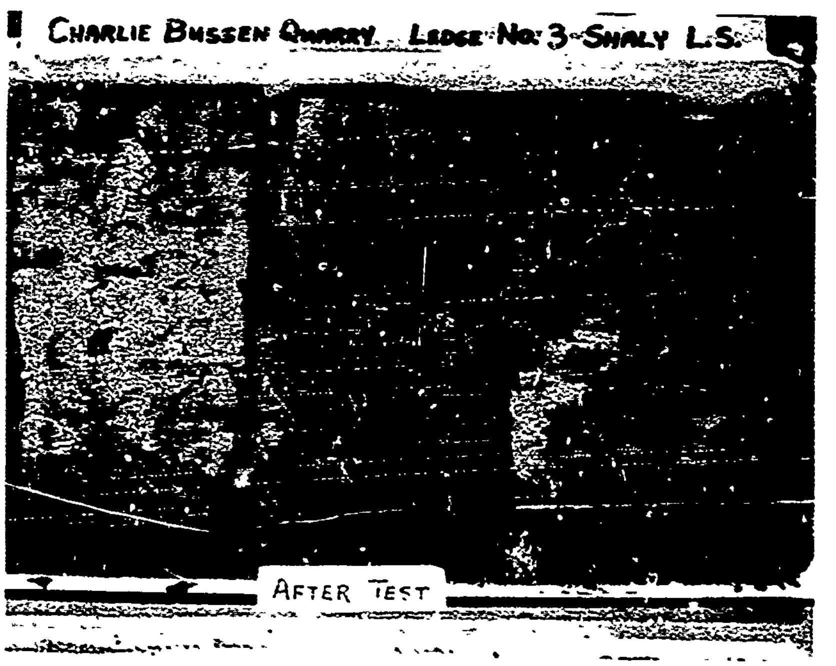


b. After test

Fig. 4B. Bussen Quarry stone from ledge No. 2 tested for freezing and thawing in an 0.5 percent solution of water and alcohol.

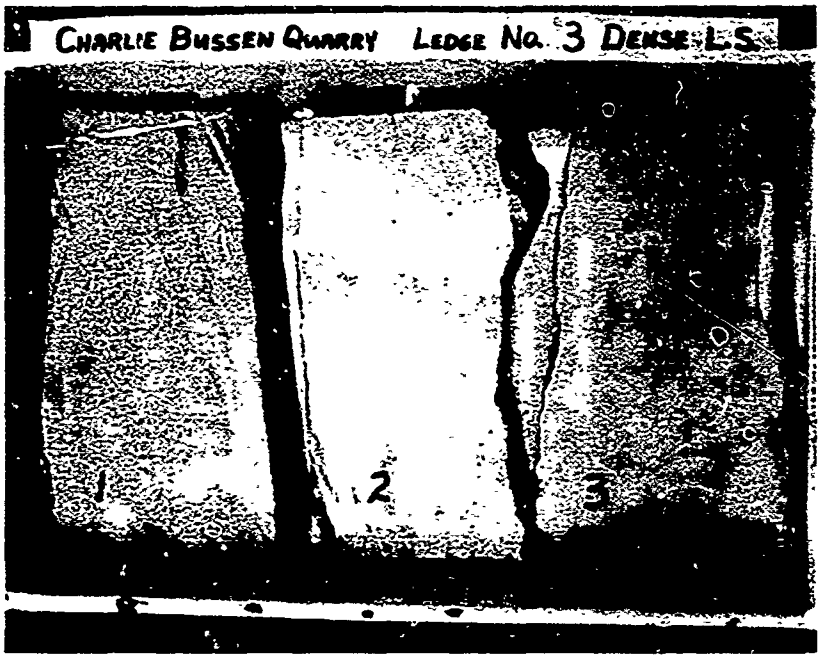


a. Before test

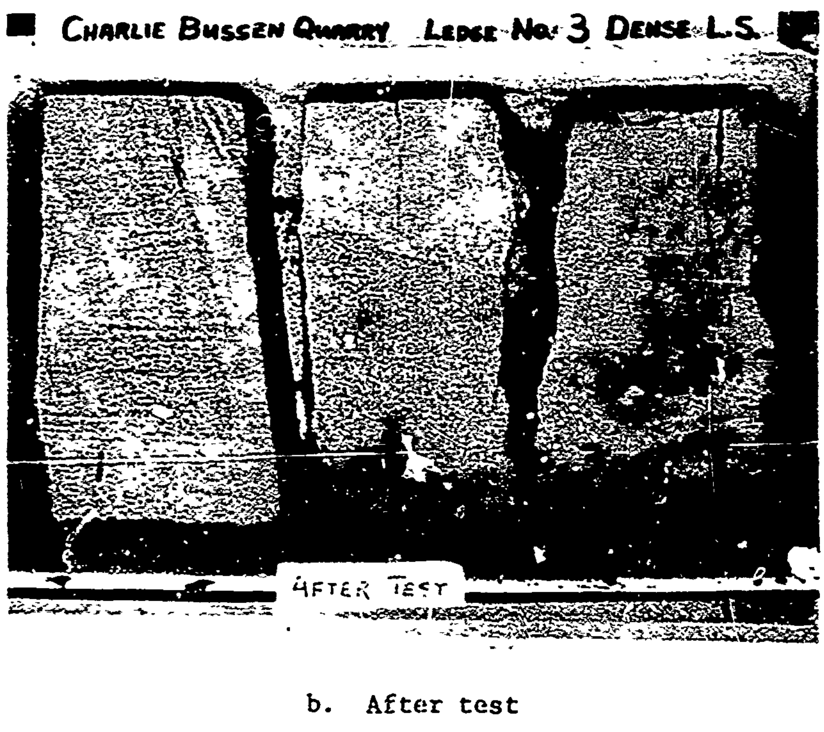


b. After test

Fig. 4C. Bussen Quarry stone from ledge 3 tested for freezing and thawing in an 0.5 percent solution of water and alcohol.

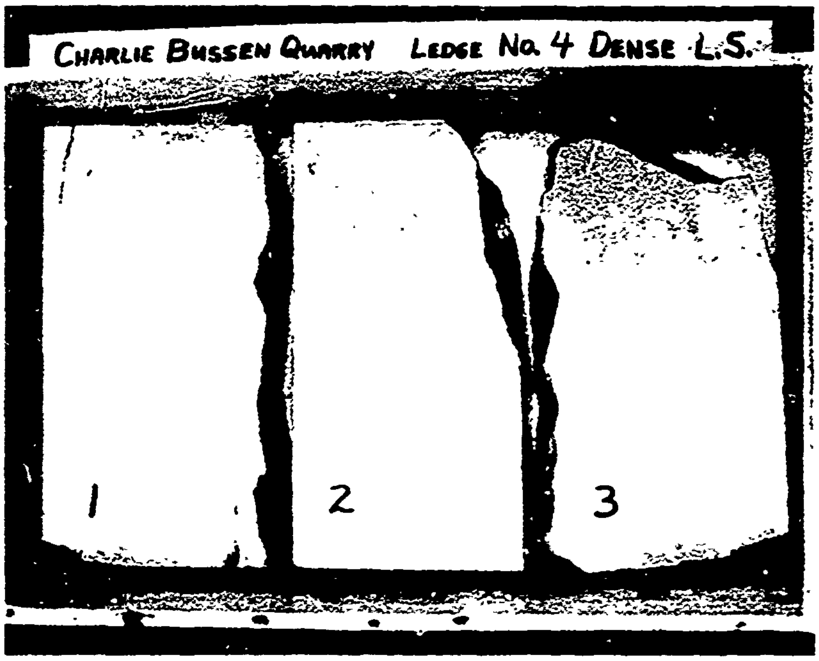


a. Before test

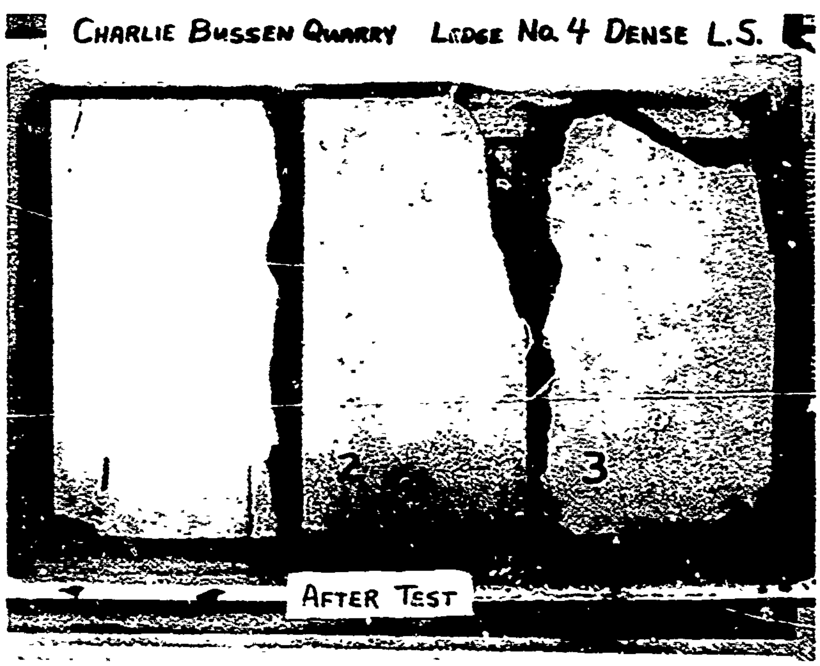


b. After test

F'g. 4D. Bussen Quarry stone from ledge 3 tested for freezing and thawing in an 0.5 percent solution of water and alcohol.



a. Before test



b. After test

Fig. 4E. Bussen Quarry stone from ledge 4 tested for freezing and thawing in an 0.5 percent solution of water and alcohol.

STATE: Missouri	INDEX NO:	RIPRAP DATA SHEET	TESTED BY [illegible]
LAT.: 38	LONG.: 90		DATE May 1965

LAB. SYMBOL NO.: Vicks-35 G-1(2) TYPE OF MATERIAL: [illegible]

LOCATION: Sec 24, R 7 E, T 39 N, Ste. Genevieve County, Missouri, 1/2 [illegible] SW of Brickeys, Missouri.

PRODUCER: Menefee Crushed Stone Co., Inc., P. O. Box 387, [illegible], [illegible]

SAMPLED BY: St. Louis District

TESTED FOR: Kaskaskia River, Illinois, Navigation Improvement

PROCESSING BEFORE TESTING:

GEOLOGICAL FORMATION AND AGE: Kimmswick limestone, Middle Ordovician Age

GRADING (CRD-C 103)(CUM. % PASSING)

SIEVE	3-6"	1½-3"	¾-1½"	#4-¾"	FINE AGG.
6 IN.					
5 IN.					
4 IN.					
3 IN.					
2½ IN.					
2 IN.					
1½ IN.					
1 IN.					
¾ IN.					
½ IN.					
⅜ IN.					
NO. 4					
NO. 8					
NO. 16					
NO. 30					
NO. 50					
NO. 100					
NO. 200					
-200(a)					
F.M.(b)					

(a) CRD-C 105 (b) CRD-C 104

TEST RESULTS

	3-6"	1½-3"	¾-1½" (c)	[illegible]	FINE AGG
BULK SP. GR., SAT SURF DRY (CRD-C 107,108):				2.[illegible]	
ABSORPTION, PER CENT (CRD-C 107,108):				0.9	
ORGANIC IMPURITIES, FIG. NO (CRD-C 121):	—	—	—	—	
SOFT PARTICLES, PER CENT (CRD-C 130):					—
PER CENT LIGHTER THAN SP.GR.____(CRD-C 129):					—
PER CENT FLAT AND ELONGATED (CRD-C 119,120):					
WEIGHTED AV. % LOSS, 5 CYC. $MgSO_4$ ((c) ½-1", #4-½)(CRD-C 115)					
ABRASION LOSS (L A), %, (CRD-C 117):				35.6	—
UNIT WT., LB/CU FT (CRD-C 107):				163.2	
Toughness (CRD-C 132):				[illegible]*	
COAL AND LIGNITE, % (CRD-C 122):	—	—	—	—	
SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):					
REACTIVITY WITH NaOH (CRD-C 128) Sc, mM/L					
Rc, mM/L					

MORTAR-MAKING PROPERTIES (CRD-C 116)

TYPE______CEMENT, RATIO______DAYS,________%,________DAYS,________%

LINEAR THERMAL EXPANSION X10⁻⁶/DEG. F. (CRD-C 125,126):

ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE

MORTAR:

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):	FINE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.	COARSE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK. CEMENT: % Na_2O EQUIVALENT:								
HIGH-ALK CEMENT: % Na_2O EQUIVALENT:								

SOUNDNESS IN CONCRETE (CRD-C 40, 114):

			F&T	HW-CD	HD-CW
FINE AGG.	COARSE AGG:	DFE_{300}			
FINE AGG.	COARSE AGG:	DFE_{300}			

PETROGRAPHIC DATA (CRD-C 127):

REMARKS: * The number to the left is the height of the blow at failure in cm., perpendicular to the structural weakness and the number to the right is the height of the blow parallel to the structural weakness of the sample.

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WES FORM 726 JAN. 1951

Corps of Engineers, USAE	Riprap Data Sheet	Concrete Division P. O. Drawer 2131 Jackson, Mississippi

Project
Kaskaskia River, Illinois, Navigation Improvement

Date
May 1965

Vicks-35 G-1(2), Ledge Rock, Menefee Quarry

Toughness (CRD-C 132):

Test No.	Height of Blow at Failure, cm: Perpendicular to Plane of Structural Weakness	Parallel to Plane of Structural Weakness
1	4	4
2	5	4
3	5	5
Avg	5	4

Freezing and Thawing in Water and Alcohol (CRD-C 144):

Type of Stone	Specimen No.	Original OD wt. g	Final OD wt. of Fragments Larger Than 25 % of Original wt. g	%	Wt Loss During Test, %	Cycles Completed
Dense	1	4084	4077	99.8	0.2	20
Limestone	2	4238	4232	99.8	0.2	20
	3	4501	4492	99.8	0.2	20
	Avg				0.2	

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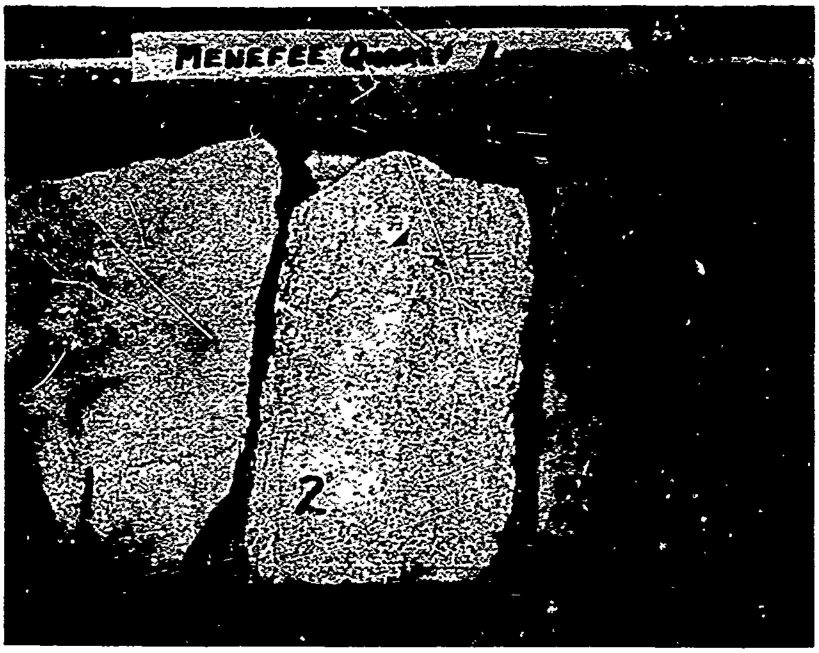
WES Form No. 1115

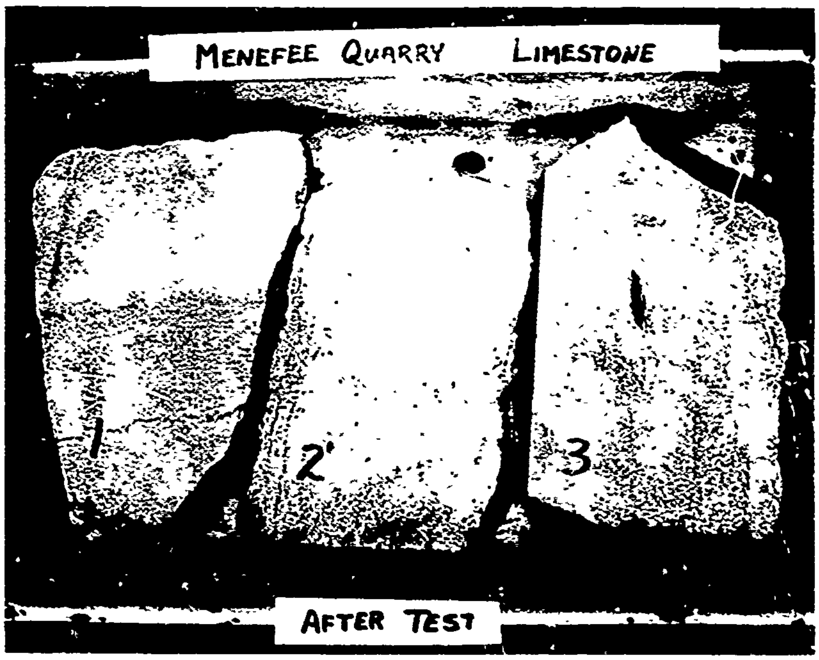
Riprap Data Sheet

After 20 cycles of freezing and thawing according to CRD-C 144 the following observation was made:

No effects of the test were apparent on the rock slabs.



a. Before test



b. After test

Fig. 5. Menefee Quarry stone tested for freezing and thawing in an 0.5 percent solution of water and alcohol.

STATE: Missouri	INDEX NO:	AGGREGATE DATA SHEET	TESTED BY: [illegible]
LAT. 37	LONG.: 89		DATE May 1965

LAB SYMBOL NO: STL-19 G-1 TYPE OF MATERIAL: Crushed [illegible]

LOCATION: Sec 11, R 12 E, T 35 [illegible], Perry County, Missouri, near [illegible], Missouri (Menefee Quarry)

PRODUCER: Southern River Rock Co., Box 33, Perryville, Missouri

SAMPLED BY: St. Louis District

TESTED FOR: Kaskaskia River, Illinois, Navigation Improvement

PROCESSING BEFORE TESTING: Crushing and separation into sizes.

GEOLOGICAL FORMATION AND AGE: Plattin limestone, Middle Ordovician Age

GRADING (CRD-C 103)(CUM. % PASSING):

SIEVE	3-6"	1½-3"	¾-1½"	#4-¾"	FINE AGG.
6 IN.					
5 IN.					
4 IN.		100			
3 IN.		95			
2½ IN.		-			
2 IN.		38	100		
1½ IN.		5	95		
1 IN.		2	32	100	
¾ IN.			5	95	
½ IN.			-	-	
⅜ IN.			2	38	
NO 4				2	
NO. 8					
NO. 16					
NO. 30					
NO. 50					
NO 100					
NO. 200					
- 200[a]					
F.M.[b]					

(a) CRD-C 105 (b) CRD-C 104

TEST RESULTS

	3-6"	1½-3"	¾-1½" (c)	#4-¾" (c)	FINE AGG
BULK SP. GR, SAT SURF DRY (CRD-C 107,108):		2.70	2.71	2.71	
ABSORPTION, PER CENT (CRD-C 107, 108):		1.4	[illegible].5	[illegible].2	
ORGANIC IMPURITIES, FIG. NO (CRD-C 121):	—	—	—	—	
SOFT PARTICLES, PER CENT (CRD-C 130):		0.0	0.0	0.0	—
PER CENT LIGHTER THAN SP. GR. ____ (CRD-C 129):					—
PER CENT FLAT AND ELONGATED (CRD-C 119,120):		3.0	6.1	5.3	
WEIGHTED AV. % LOSS, 5 CYC. $MgSO_4$ ((c) ¾-1", #4-½) (CRD-C 115)				5.6	
ABRASION LOSS (L A), %, (CRD-C 117):		[illegible]	[illegible]	[illegible]	—
UNIT WT., LB/CU FT (CRD-C 106):					
CLAY LUMPS, % (CRD-C 118)					
COAL AND LIGNITE, % (CRD-C 122):	—	—	—	—	
SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):					
REACTIVITY WITH NaOH (CRD-C 128): Sc, mM/L					
Rc, mM/L					

MORTAR-MAKING PROPERTIES (CRD-C 116)

TYPE ____ CEMENT, RATIO ____ DAYS, ____ %, ____ DAYS, ____ %

LINEAR THERMAL EXPANSION X10 /DEG. F. (CRD-C 125,126)

ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE

MORTAR:

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):	FINE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.	COARSE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK CEMENT: % Na_2O EQUIVALENT:								
HIGH-ALK. CEMENT: % Na_2O EQUIVALENT:								

SOUNDNESS IN CONCRETE (CRD-C 40, 114):

			F & T	HW-CD	HD-CA
FINE AGG. STL-19 S-1(4)	COARSE AGG: STL-19 G-1	DFE 300	81		
FINE AGG.	COARSE AGG:	DFE 300			

PETROGRAPHIC DATA (CRD-C 127):

REMARKS:

WES FORM 726 JAN. 1951

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FROM: CORPS OF ENGINEERS U. S. ARMY Lower Miss. Valley DIVISION	REPORT OF SOUNDNESS TEST (CRD-C 115)	[illegible]: USAEWES P. O. Drawer 2131 Jackson, Mississippi 39205
SYMBOL STL-19 Job No. 6624	PROJECT Kaskaskia River Nav. Imp.	MATERIAL Crushed limestone
SERIAL NO. STL-19 C-1	SOURCE Southern River Rock Co., G[illegible]ar Quarry, Perryville, Missouri	

COARSE AGGREGATE

SIEVE SIZE	GRADING FOR CALCULATION (Per Cent)	WEIGHT OF TEST FRACTIONS BEFORE TEST (Grams)		WEIGHT OF TEST FRACTIONS AFTER TEST (Grams)		WEIGHT PASSING FINER SIEVE AFTER TEST ACTUAL LOSS (g)		% PASSING FINER SIEVE AFTER TEST ACTUAL % LOSS		WEIGHTED AVG CORRECTED PER CENT LOSS	
		RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2
NO. 4 TO 3/4 IN.	50	750	750	705.5	693.6	44.5	56.4	5.9	7.5	2.95	3.75
3/4 TO 1 IN.	50	1500	1500	1390.6	1412.7	109.4	87.3	7.3	5.8	3.65	2.90
	TOTALS	2250	2250	2096.1	2106.3	153.9	143.7	-	-	6.60	6.65

SUM WEIGHTED AVG RUNS 1 & 2 13.25

AVG TOTAL WEIGHTED AVG RUNS 1 & 2 6 PER CENT

CONSTITUENT (Size 3/4 to 1 in.)	NO. OF PARTICLES BEFORE TEST		NO. PARTICLES AFTER TEST: SPLIT		CRUMBLED		CRACKED		[illegible]		[illegible]		TOTAL	
	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2
Limestone	42	42	1	1	3	2	0	0	15	13	23	26	42	42

FINE AGGREGATE

SIEVE SIZE	GRADING FOR CALCULATION (%)	WEIGHT OF TEST FRACTIONS BEFORE TEST (Grams)		WEIGHT OF TEST FRACTIONS AFTER TEST (Grams)		% PASSING FINER SIEVE AFTER TEST ACTUAL % LOSS		WEIGHTED AVERAGE CORRECTED % LOSS	
		RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2
3/8-IN.-NO. 4	2-								
NO. 4-8	13								
NO. 8-16	20								
NO. 16-30	20								
NO. 30-50	24								
NO. 50-100	14	-	-	-	-	0.0	0.0	0.0	0.0
NO. 100-PAN	7	-	-	-	-	0.0	0.0	0.0	0.0
TOTALS	100								

SUM WEIGHTED AVG RUNS 1 & 2

AVG TOTAL WEIGHTED AVG RUNS 1 & 2 PER CENT

REMARKS

COARSE BY JEJ	CHECKED [illegible]
FINE BY	DATE OF REPORT
COMPUTED JEJ	May 1965

WES FORM 477
REV. DEC. 1955

STATE: Missouri	INDEX NO:	AGGREGATE DATA SHEET	TESTED BY: [illegible]
LAT.: 38	LONG.: 90		DATE: [illegible] 1965

LAB. SYMBOL NO.: STL-19 G-2 TYPE OF MATERIAL: [illegible]

LOCATION: Sec 17, R 9 E, T 38 N, Ste. Genevieve County, Missouri, nr [illegible] Rock, Missouri.

PRODUCER: West Lake Quarry and Materials Co., Box 205, [illegible], Bridgeton, Missouri

SAMPLED BY: St. Louis District

TESTED FOR: Kaskaskia River Navigation Improvement

PROCESSING BEFORE TESTING: Crushing and separating into sizes.

GEOLOGICAL FORMATION AND AGE: Ste. Genevieve limestone and St. Louis limestone, Meramec group, Middle Mississippian Age

GRADING (CRD-C 103)(CUM. % PASSING):

SIEVE	3-6"	1½-3"	¾-1½"	#4-¾"	FINE AGG.
6 IN.					
5 IN.					
4 IN.		100			
3 IN.		95			
2½ IN.		-			
2 IN.		33	100		
1½ IN.		5	95		
1 IN.		2	32	100	
¾ IN.			5	95	
½ IN.			-	-	
⅜ IN.			2	23	
NO 4				2	
NO. 8					
NO. 16					
NO 30					
NO. 50					
NO 100					
NO. 200					
- 200(a)					
F.M.(b)					

(a) CRD-C 105 (b) CRD-C 104

TEST RESULTS

	3-6"	1½-3"	¾-1½" (c)	#4-¾" (c)	FINE AGG.
BULK SP. GR., SAT SURF DRY (CRD-C 107,108):		2.68	2.67	2.67	
ABSORPTION, PER CENT (CRD-C 107,108):		0.6	0.8	[illegible]	
ORGANIC IMPURITIES, FIG. NO (CRD-C 121):	—	—	—	—	
SOFT PARTICLES, PER CENT (CRD-C 130):		2.9	3.6	2.6	—
PER CENT LIGHTER THAN SP.GR.____(CRD-C 129):					—
PER CENT FLAT AND ELONGATED (CRD-C 119,120):		[illegible]9.3*	[illegible]4.0*	[illegible]4.7	
WEIGHTED AV. % LOSS, 5 CYC. $MgSO_4$ ((c) ¾-1", #4-¾)(CRD-C 115)		-	[illegible]		
ABRASION LOSS (L. A.), %, (CRD-C 117):		[illegible]	[illegible]	[illegible]	—
UNIT WT., LB/CU FT (CRD-C 106):					
CLAY LUMPS, % (CRD-C 118)					
COAL AND LIGNITE, % (CRD-C 122):	—	—	—	—	
SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):					
REACTIVITY WITH NaOH (CRD-C 128): Sc, mM/L:					
Rc, mM/L:					

MORTAR-MAKING PROPERTIES (CRD-C 116)

TYPE______CEMENT, RATIO______DAYS,________%,________DAYS,________%

LINEAR THERMAL EXPANSION X10⁻⁶/DEG. F. (CRD-C 125,126):

ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE

MORTAR:

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):	FINE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.	COARSE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK. CEMENT: % Na_2O EQUIVALENT:								
HIGH-ALK. CEMENT: % Na_2O EQUIVALENT:								

SOUNDNESS IN CONCRETE (CRD-C 40, 114):			F L T	HW-CD	HD-CW
FINE AGG. STL-5 S-5(4) STL-19 S-1	COARSE AGG: STL-19 G-2	DFE_{300}	60		
FINE AGG.	COARSE AGG:	DFE_{300}			

PETROGRAPHIC DATA (CRD-C 127):

REMARKS:

* Poor particle shape resulted from testing crushed cores.

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WES FORM 726 JAN. 1951

FROM: CORPS OF ENGINEERS U. S. ARMY Lower Miss. Valley DIVISION	**REPORT OF SOUNDNESS TEST** *(CRD-C 115)*	ADDRESS: [illegible] P. O. Drawer 2131 Jackson, Mississippi 39205

SYMBOL STL-19 Job No. 6524	PROJECT Kaskaskia River Nav. Imp.	MATERIAL Crushed limestone
SERIAL NO. STL-19 G-2	SOURCE West Lake Quarry and Materials Co., Bridgeton, Missouri	

COARSE AGGREGATE

SIEVE SIZE	GRADING FOR CALCULATION *(Per Cent)*	WEIGHT OF TEST FRACTIONS BEFORE TEST *(Grams)*		WEIGHT OF TEST FRACTIONS AFTER TEST *(Grams)*		WEIGHT PASSING FINER SIEVE AFTER TEST ACTUAL LOSS (g)		% PASSING FINER SIEVE AFTER TEST ACTUAL % LOSS		WEIGHTED AVG CORRECTED PER CENT LOSS	
		RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2
NO. 4 TO 3/4 IN	50	750	750	632.0	639.2	118.0	110.8	15.7	14.8	7.65	7.40
3/4 TO 1 IN	50	1500	1500	1318.1	1333.7	181.9	166.3	12.1	11.1	6.05	5.55
	TOTALS	2250	2250	1950.1	1972.9	299.9	277.1	-	-	13.90	12.95
						SUM WEIGHTED AVG RUNS 1 & 2				26.85	
						AVG TOTAL WEIGHTED AVG RUNS 1 & 2				13.4	PER CENT

CONSTITUENT *(Size ¾ to 1 in.)*	NO. OF PARTICLES BEFORE TEST RUN 1	RUN 2	SPLIT RUN 1	RUN 2	CRUMBLED RUN 1	RUN 2	CRACKED RUN 1	RUN 2	FLAKED RUN 1	RUN 2	SOUND RUN 1	RUN 2	TOTAL RUN 1	RUN 2
Limestone	41	40	1	1	10	6	1	0	16	18	13	15	41	40

FINE AGGREGATE

SIEVE SIZE	GRADING FOR CALCULATION (%)	WEIGHT OF TEST FRACTIONS BEFORE TEST *(Grams)* RUN 1	RUN 2	WEIGHT OF TEST FRACTIONS AFTER TEST *(Grams)* RUN 1	RUN 2	% PASSING FINER SIEVE AFTER TEST ACTUAL % LOSS RUN 1	RUN 2	WEIGHTED AVERAGE CORRECTED % LOSS RUN 1	RUN 2
3/8-IN.-NO. 4	2								
NO. 4-8	13								
NO. 8-16	20								
NO. 16-30	20								
NO. 30-50	24								
NO. 50-100	14	-	-	-	-	0.0	0.0	0.0	0.0
NO. 100-PAN	7	-		-	-	0.0	0.0	0.0	0.0
TOTALS	100								
						SUM WEIGHTED AVG RUNS 1 & 2			
						AVG TOTAL WEIGHTED AVG RUNS 1 & 2			PER CENT

REMARKS

COARSE BY [illegible]	CHECKED BJH	
FINE BY	DATE OF REPORT	
COMPUTED [illegible]	May 1965	

WES FORM 477
REV. DEC. 1955

AGGREGATE DATA SHEET

STATE: Illinois INDEX NO:
LAT: [illegible] LONG.: 90
TESTED BY: [illegible]
DATE: [illegible]

LAB. SYMBOL NO.: STL-19 C-3 TYPE OF MATERIAL: [illegible]

LOCATION: Sec. 16, R 9 W, T 5 S, Randolph County, Illinois, 1/2 mile N of Prairie du Rocher, Illinois

PRODUCER: Stotz Quarry, Prairie du Rocher, Illinois

SAMPLED BY: St. Louis District

TESTED FOR: Kaskaskia River, Illinois, Navigation Improvement

PROCESSING BEFORE TESTING: Crushing and separation into sizes

GEOLOGICAL FORMATION AND AGE: Salem limestone, Meramec group, Middle Mississippian Age

GRADING (CRD-C 103)(CUM % PASSING):

SIEVE	3-6"	1½-3"	¾-1½"	#4-¾"	FINE AGG.
6 IN.					
5 IN.					
4 IN.		100			
3 IN.		95			
2½ IN.		-			
2 IN.		33	100		
1½ IN.		5	95		
1 IN.		2	33	100	
¾ IN.			5	95	
½ IN.			-	-	
⅜ IN.			2	38	
NO. 4				2	
NO. 8					
NO. 16					
NO. 30					
NO. 50					
NO. 100					
NO. 200					
-200[a]					
F.M.[b]					

(a) CRD-C 105 (b) CRD-C 104

TEST RESULTS

	3-6"	1½-3"	¾-1½" (c)	#4-¾" (c)	FINE AGG.
BULK SP. GR., SAT SURF DRY (CRD-C 107,108)		2.68	2.68	2.68	
ABSORPTION, PER CENT (CRD-C 107,108)		0.4	0.5	0.7	
ORGANIC IMPURITIES, FIG. NO (CRD-C 121)	—	—	—	—	
SOFT PARTICLES, PER CENT (CRD-C 130)		0.0	0.6	0.0	—
PER CENT LIGHTER THAN SP.GR.____ (CRD-C 129)					—
PER CENT FLAT AND ELONGATED (CRD-C 119,120)		0.[illegible]	1.6	2.[illegible]	
WEIGHTED AV. % LOSS, 5 CYC. $MgSO_4$ ((c) ¾-1", #4-¾")(CRD-C 115)				2.8	
ABRASION LOSS (L.A.), %, (CRD-C 117)		25.3	32.6	[illegible]	—
UNIT WT., LB/CU FT (CRD-C 106)					
CLAY LUMPS, % (CRD-C 118)					
COAL AND LIGNITE, % (CRD-C 122)	—	—	—	—	
SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124)					
REACTIVITY WITH NaOH (CRD-C 128) Sc, mM/L					
Rc, mM/L					

MORTAR-MAKING PROPERTIES (CRD-C 115)
TYPE____CEMENT, RATIO____DAYS,____%,____DAYS,____%

LINEAR THERMAL EXPANSION X10⁻⁶/DEG. F. (CRD-C 125,126)

ROCK TYPE	PARALLEL	ACROSS	CN	AVERAGE

MORTAR:

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):

		FINE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.	COARSE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK. CEMENT:	% Na_2O EQUIVALENT:								
HIGH-ALK. CEMENT:	% Na_2O EQUIVALENT:								

SOUNDNESS IN CONCRETE (CRD-C 40, 114):

			F & T	NW-CD	ND-CW
FINE AGG. [illegible]	COARSE AGG.: STL-19 G-3	DFE₃₀₀	81		
FINE AGG. [illegible]	COARSE AGG.:	DFE₃₀₀			

PETROGRAPHIC DATA (CRD-C 127):

REMARKS:

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WES FORM 726 JAN. 1951

FROM: CORPS OF ENGINEERS U. S. ARMY Lower Miss. Valley DIVISION	**REPORT OF SOUNDNESS TEST** *(CRD-C 115)*	[illegible] 2131 Jackson, Mississippi 39205
SYMBOL STL-19 Job 5626	PROJECT Kaskaskia River Nav. Imp.	MATERIAL [illegible]
SERIAL NO. STL-19 G-3	SOURCE Stone Quarry - Prairie du Rocher, Illinois	

COARSE AGGREGATE

SIEVE SIZE	GRADING FOR CALCULATION *(Per Cent)*	WEIGHT OF TEST FRACTIONS BEFORE TEST *(Grams)* Run 1	Run 2	WEIGHT OF TEST FRACTIONS AFTER TEST *(Grams)* Run 1	Run 2	WEIGHT PASSING FINER SIEVE AFTER TEST ACTUAL LOSS (g) Run 1	Run 2	% PASSING FINER SIEVE AFTER TEST ACTUAL % LOSS Run 1	Run 2	WEIGHTED AVG CORRECTED PER CENT LOSS Run 1	Run 2
NO. 4 TO 3/8 IN.	50	75[illegible]	750	72[illegible].5	732.[illegible]	2[illegible]	[illegible]	[illegible]	3[illegible]	[illegible]	[illegible]
3/8 TO 1 IN.	50	150[illegible]	1500	[illegible]470.6	[illegible]	29.1	[illegible]	1.9	3.9	0.95	1.95
	TOTALS	2250	22[illegible]	[illegible]	2174.0	50.6	[illegible]	-	-	[illegible]	3.[illegible]

SUM WEIGHTED AVG RUNS 1 & 2 5.55

AVG TOTAL WEIGHTED AVG RUNS 1 & 2 [illegible] PER CENT

CONSTITUENT *(Size 3/8 to 1 in.)*	NO. OF PARTICLES BEFORE TEST Run 1	Run 2	NO. PARTICLES AFTER TEST: SPLIT Run 1	Run 2	[illegible] Run 1	Run 2	[illegible] Run 1	Run 2	[illegible] Run 1	Run 2	TOTAL Run 1	Run 2
Limestone	56	56	2	1	1	[illegible]	[illegible]	[illegible]	9	7	[illegible]	[illegible]

FINE AGGREGATE

SIEVE SIZE	GRADING FOR CALCULATION (%)	WEIGHT OF TEST FRACTIONS BEFORE TEST *(Grams)* Run 1	Run 2	WEIGHT OF TEST FRACTIONS AFTER TEST *(Grams)* Run 1	Run 2	% PASSING FINER SIEVE AFTER TEST ACTUAL % LOSS Run 1	Run 2	WEIGHTED AVERAGE CORRECTED % LOSS Run 1	Run 2
3/8-IN.-NO. 4	2								
NO. 4-8	13								
NO. 8-16	20								
NO. 16-30	20								
NO. 30-50	24								
NO. 50-100	14	-	-	-	-	0.0	0.0	0.0	0.0
NO. 100-PAN	7	-	-	-	-	0.0	0.0	0.0	0.0
TOTALS	100								

SUM WEIGHTED AVG RUNS 1 & 2

AVG TOTAL WEIGHTED AVG RUNS 1 & 2 PER CENT

REMARKS

COARSE BY [illegible]	CHECKED BY B.[illegible]	
FINE BY	DATE OF REPORT	
COMPUTED [illegible]	May 1965	

WES FORM 477
REV. DEC. 1955

STATE: Missouri | INDEX NO: | **AGGREGATE DATA SHEET** | TESTED BY: USAEWES

LAT: 38 | LONG: 90 | DATE: May 1965

LAB SYMBOL NO: Vicks-35 G-1(2) TYPE OF MATERIAL: Crushed limestone

LOCATION: Sec 24, R / E, T 39 N, Ste. Genevieve County, Missouri, 1/2 mile SW of Brickeys, Missouri

PRODUCER: Menefee Crushed Stone Co., Inc., P. O. Box 387, Nashville, Tenn.

SAMPLED BY: St. Louis District

TESTED FOR: Kaskaskia River, Illinois, Navigation Improvement

PROCESSING BEFORE TESTING: Crushing and separating into sizes.

GEOLOGICAL FORMATION AND AGE: Kimmswick limestone, Middle Ordovician Age

GRADING (CRD-C 103)(CUM. % PASSING):

SIEVE	3-6"	1½-3"	¾-1½"	#4-¾"	FINE AGG
6 IN.					
5 IN.					
4 IN		100			
3 IN.		95			
2½ IN.		-			
2 IN.		38	100		
1½ IN.		5	95		
1 IN.		2	32	100	
¾ IN.			5	95	
½ IN.			-	-	
⅜ IN.			2	38	
NO 4				2	
NO 8					
NO 16					
NO 30					
NO 50					
NO 100					
NO 200					
-200[a]					
F M[b]					

(a) CRD-C 105 (b) CRD-C 104

TEST RESULTS

	3-6"	1½-3"	¾-1½" (c)	#4-¾" (c)	FINE AGG
BULK SP GR, SAT SURF DRY (CRD-C 107,108):		2.62	2.62	2.61	
ABSORPTION, PER CENT (CRD-C 107,108):		1.0	1.2	1.7	
ORGANIC IMPURITIES, FIG. NO. (CRD-C 121):	—	—	—	—	
SOFT PARTICLES, PER CENT (CRD-C 130):		7.1	7.2	9.8	—
PER CENT LIGHTER THAN SP.GR.____ (CRD-C 129):					—
PER CENT FLAT AND ELONGATED (CRD-C 119,120):		1.9	4.7	0.8	
WEIGHTED AV. % LOSS, 5 CYC $MgSO_4$ ((c) ¾-1", #4-¾)(CRD-C 115)				6.8	
ABRASION LOSS (L.A.), %, (CRD-C 117):		43.8	51.2	44.0	—
UNIT WT., LB/CU FT (CRD-C 106)					
CLAY LUMPS, % (CRD-C 118)					
COAL AND LIGNITE, % (CRD-C 122):	—	—	—	—	
SPECIFIC HEAT, BTU/LB/DEG. F (CRD-C 124):					
REACTIVITY WITH NaOH (CRD-C 128) Sc, mM/L:					
Rc, mM/L:					

MORTAR-MAKING PROPERTIES (CRD-C 116)

TYPE____CEMENT, RATIO____DAYS,____%,____DAYS,____%

LINEAR THERMAL EXPANSION X10⁻⁶/DEG. F. (CRD-C 125,126):

ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE

MORTAR:

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123)	FINE AGGREGATE				COARSE AGGREGATE			
	3 MO	6 MO.	9 MO.	12 MO.	3 MO	6 MO.	9 MO	12 MO.
LOW-ALK CEMENT: % Na_2O EQUIVALENT:								
HIGH-ALK CEMENT % Na_2O EQUIVALENT:								

SOUNDNESS IN CONCRETE (CRD-C 40, 114):			F & T	HW-CD	HD-CW
FINE AGG. STL-19 S-1 3-?-5 S-3(4)	COARSE AGG: VICKS-35 G-1(2)	DFE300	81		
FINE AGG.	COARSE AGG:	DFE300			

PETROGRAPHIC DATA (CRD-C 127):

REMARKS:

WES FORM 726 JAN. 1951

FROM: CORPS OF ENGINEERS U. S. ARMY Lower Miss. Valley DIVISION	REPORT OF SOUNDNESS TEST (CRD-C 115)	ADDRESS: USAEWES P. O. Drawer 2131 Jackson, Mississippi 39205
SYMBOL Vicks-35 Job No. 6626	PROJECT Kaskaskia River Nav. Imp.	MATERIAL Crushed limestone
SERIAL NO. Vicks-35 G-1(2)	SOURCE Menefee Quarry, Brickeys, Missouri	

COARSE AGGREGATE

SIEVE SIZE	GRADING FOR CALCULATION (Per Cent)	WEIGHT OF TEST FRACTIONS BEFORE TEST (Grams)		WEIGHT OF TEST FRACTIONS AFTER TEST (Grams)		WEIGHT PASSING FINER SIEVE AFTER TEST ACTUAL LOSS (g)		% PASSING FINER SIEVE AFTER TEST ACTUAL % LOSS		WEIGHTED AVG CORRECTED PER CENT LOSS	
		RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2
NO. 4 TO ¾ IN	50	750	750	670.0	688.7	80.0	61.3	10.7	6.2	5.35	4.10
¾ TO 1 IN	50	1500	1500	1439.2	1437.8	60.8	62.2	4.1	4.1	2.05	2.05
	TOTALS	2250	2250	2109.2	2126.5	140.8	123.5	-	-	7.40	6.15
						SUM WEIGHTED AVG RUNS 1 & 2				13.55	-
						AVG TOTAL WEIGHTED AVG RUNS 1 & 2				6.8 PER CENT	

CONSTITUENT (Size ¾ to 1 in.)	NO. OF PARTICLES BEFORE TEST		SPLIT		CRUMBLED		CRACKED		FLAKED		SOUND		TOTAL	
	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2
Crushed limestone	51	51	0	1	4	3	0	0	26	25	21	22	51	51

(SPLIT, CRUMBLED, CRACKED, FLAKED, SOUND and TOTAL under: NO. PARTICLES AFTER TEST)

FINE AGGREGATE

SIEVE SIZE	GRADING FOR CALCULATION (%)	WEIGHT OF TEST FRACTIONS BEFORE TEST (Grams)		WEIGHT OF TEST FRACTIONS AFTER TEST (Grams)		% PASSING FINER SIEVE AFTER TEST ACTUAL % LOSS		WEIGHTED AVERAGE CORRECTED % LOSS	
		RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2
3/8-IN.-NO. 4	2								
NO. 4-8	13								
NO. 8-16	20								
NO. 16-30	20								
NO. 30-50	24								
NO. 50-100	14	-	-	-	-	0.0	0.0	0.0	0.0
NO. 100-PAN	7	-	-	-	-	0.0	0.0	0.0	0.0
TOTALS	100								
						SUM WEIGHTED AVG RUNS 1 & 2			
						AVG TOTAL WEIGHTED AVG RUNS 1 & 2		PER CENT	

REMARKS

COARSE BY JPJ	CHECKED BJH	
FINE BY	DATE OF REPORT May 1965	
COMPUTED JPJ		

WES FORM 477
REV. DEC. 1955

STATE: Illinois	INDEX NO: 13	AGGREGATE DATA SHEET	TESTED BY: USAEWES
LAT: 37	LONG: 89		DATE: May 1965

LAB SYMBOL NO: STL-5 S-3(4) TYPE OF MATERIAL: Natural sand

LOCATION: Mississippi River at Chester, Illinois., NE 1/4, Sec 24, T 7 S, R 7 W, Randolph County, Illinois

PRODUCER: Southern Illinois Sand Co., Chester, Illinois

SAMPLED BY: St. Louis District

TESTED FOR: Kaskaskia River, Illinois, Navigation Improvement

PROCESSING BEFORE TESTING: None

GEOLOGICAL FORMATION AND AGE:

GRADING (CRD-C 103)(CUM % PASSING):

SIEVE	3-6"	1½-3"	¾-1½"	#4-¾"	FINE AGG
6 IN.					
5 IN.					
4 IN.					
3 IN.					
2½ IN.					
2 IN.					
1½ IN.					
1 IN.					
¾ IN.					
½ IN.					
⅜ IN.					100
NO. 4					98
NO. 8					89
NO. 16					65
NO. 30					29
NO. 50					4
NO. 100					1
NO. 200					0
-200 (a)					0
F.M. (b)					3.10

(a) CRD-C 105 (b) CRD-C 104

TEST RESULTS

	3-6"	1½-3"	¾-1½" (c)	#4-¾" (c)	FINE AGG.
BULK SP. GR., SAT SURF DRY (CRD-C 107, 108):					2.63
ABSORPTION, PER CENT (CRD-C 107, 108):					0.4
ORGANIC IMPURITIES, FIG. NO (CRD-C 121):	—	—	—	—	5*
SOFT PARTICLES, PER CENT (CRD-C 130):					—
PER CENT LIGHTER THAN SP. GR. ____ (CRD-C 129):					—
PER CENT FLAT AND ELONGATED (CRD-C 119, 120):					
WEIGHTED AV. % LOSS, 5 CYC. $MgSO_4$ ((c) ¾-1½", #4-¾) (CRD-C 115)					
ABRASION LOSS (L. A.), %, (CRD-C 117):					—
UNIT WT., LB/CU FT (CRD-C 106):					
CLAY LUMPS, % (CRD-C 118)					
COAL AND LIGNITE, % (CRD-C 122):	—	—	—	—	
SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):					
REACTIVITY WITH NaOH (CRD-C 128): Sc, mM/L					
Rc, mM/L					

MORTAR-MAKING PROPERTIES (CRD-C 116)

TYPE III CEMENT, RATIO 3 DAYS 103 %, 7 DAYS 99 %

LINEAR THERMAL EXPANSION X10⁻⁶/DEG. F. (CRD-C 125, 126):

ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE

MORTAR:

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):	FINE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.	COARSE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK CEMENT: % Na_2O EQUIVALENT:								
HIGH-ALK CEMENT: % Na_2O EQUIVALENT:								

SOUNDNESS IN CONCRETE (CRD-C 40, 114):	F & T	HW-CD	HD-CW
FINE AGG. COARSE AGG: DFE_{300}			
FINE AGG COARSE AGG: DFE_{300}			

Mortar-Making Properties (CRD-C 116)*

Combination of STL-5 S-3(4) and STL-19 S-1

Washed (3 percent NaOH)	3 days	3450,	7 days	5180
Unwashed	3 days	3480,	7 days	5220
Percent of washed	3 days	101,	7 days	101

Organic Impurities, Fig. No. after washing with 3 percent solution of sodium hydroxide (CRD-C 121): 2.*

REMARKS:

[illegible] paragraph 3.1.4.3 of CRD-C 131-55 Federal Specification Aggregate; (for) Portland-Cement-Concrete, Handbook for Concrete and Cement.

WES FORM 726 JAN 1951

STATE: Illinois	INDEX NO:	AGGREGATE DATA SHEET	TESTED BY: USAEWES
LAT. 38	LONG. 89		DATE: May 1965

LAB. SYMBOL NO. STL-19 S-1 TYPE OF MATERIAL: Natural sand

LOCATION 2-1/2 miles SW of Evansville, Illinois, Randolph County, Illinois

PRODUCER Ruma Asphalt Co., Ruma, Illinois

SAMPLED BY: St. Louis District

TESTED FOR: Kaskaskia River, Illinois, Navigation Improvement

PROCESSING BEFORE TESTING None

GEOLOGICAL FORMATION AND AGE Residual Cypress sandstone, upper Mississippian Age

GRADING (CRD-C 103)(CUM % PASSING):

SIEVE	3-6"	1½-3"	¾-1½"	#4-¾"	FINE AGG
6 IN.					
5 IN.					
4 IN.					
3 IN.					
2½ IN.					
2 IN.					
1½ IN.					
1 IN.					
¾ IN.					
½ IN.					
⅜ IN.					
NO. 4					
NO. 8					
NO. 16					
NO. 30					
NO. 50					100
NO. 100					78
NO. 200					7
-200(a)					7
F.M.(b)					0.22

(a) CRD-C 105 (b) CRD-C 104

TEST RESULTS

	3-6"	1½-3"	¾-1½" (c)	#4-¾" (c)	FINE AGG
BULK SP GR, SAT SURF DRY (CRD-C 107,108):					2.
ABSORPTION, PER CENT (CRD-C 107,108):					
ORGANIC IMPURITIES, FIG. NO (CRD-C 121):	—	—	—	—	
SOFT PARTICLES, PER CENT (CRD-C 130):					
PER CENT LIGHTER THAN SP GR ____ (CRD-C 129):					
PER CENT FLAT AND ELONGATED (CRD-C 119,120):					
WEIGHTED AV. % LOSS, 5 CYC. $MgSO_4$ ((c) ¾-1½", #4-¾") (CRD-C 115)					
ABRASION LOSS (L. A), %, (CRD-C 117):					—
UNIT WT., LB/CU FT (CRD-C 106):					
CLAY LUMPS, % (CRD-C 118)					
COAL AND LIGNITE, % (CRD-C 122):	—	—	—	—	
SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):					
REACTIVITY WITH NaOH (CRD-C 128) Sc, mM/L:					
Rc, mM/L:					

MORTAR-MAKING PROPERTIES (CRD-C 116)

TYPE ____ CEMENT, RATIO ____ DAYS, ____ %, ____ DAYS, ____ %

LINEAR THERMAL EXPANSION X10 ⁶/DEG. F. (CRD-C 125,126):

ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE

MORTAR:

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):	FINE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.	COARSE AGGREGATE 3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK CEMENT: % Na_2O EQUIVALENT:								
HIGH-ALK CEMENT: % Na_2O EQUIVALENT:								

SOUNDNESS IN CONCRETE (CRD-C 40, 114):			F & T	HW-CD	HD-CW
FINE AGG.	COARSE AGG:	DFE_{300}			
FINE AGG	COARSE AGG:	DFE_{300}			

PETROGRAPHIC DATA (CRD-C 127):

Constituents	Percent Composition
Quartz	74
Chert	10
Feldspar	6
Miscellaneous*	10

REMARKS: * Includes micas, carbonates, hornblende, garnet, and various other rocks and minerals.

WES FORM 726 JAN. 1951